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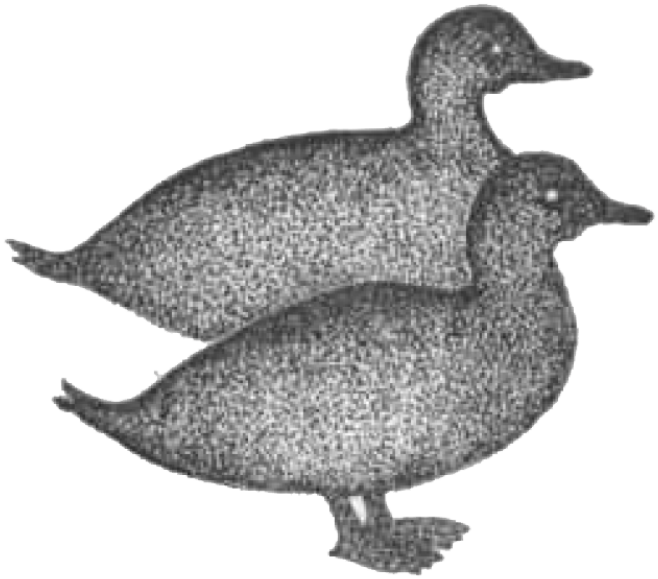
Survey of the Avian Alimentary Tract



DWT Crompton & MC Nesheim

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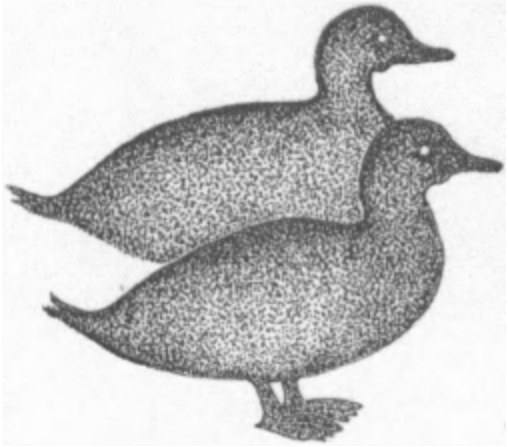
Contents



Survey of the alimentary tract of birds

DWT Crompton
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Preface

Our collaboration began in 1965 with a mutual interest in digestion in birds and how helminths (parasitic worms) live in the avian alimentary tract. We studied host-parasite relations between ducks and *Polymorphus minutus* (Acanthocephala) but this system proved hard to maintain in the laboratory. We switched to the rat - *Moniliformis dubius* (Acanthocephala) relationship (Nesheim *et al,* 1977; Parshad *et al,* 1980). Later we published a review that showed we had diverted to help assess the impact of helminth infection on the digestive physiology, nutritional status and growth of children in developing countries (Crompton & Nesheim, 2002). Our work took us to Burma (now Myanmar), China, Dominican Republic, India, Kenya, Mexico, Nigeria, Panama, Sierra Leone and Venezuela. Visits were made to Egypt, Indonesia, Pakistan, Sri Lanka, Seychelles and Vietnam to encourage governments and agencies to bring helminth infections under control. We were part of the drive to convince Ministries of Health that the NTDs (Neglected Tropical Diseases) represent a global public health problem (WHO, 2010).

Purpose of the survey

Now, some 40 years later, we have returned to the subject of our original collaboration. In the early 1970's we began an extensive project to document variation in the digestive system anatomy of a wide range of birds. We intended to relate the anatomical variations observed to the dietary practices of the bird. We were also seeking to address the question how do helminths thrive in the habitats to be found in the avian alimentary tract? *Psilostomum ondatrae* (Trematoda) lives in the proventriculus of pigeons (Beaver, 1939), *Diphyllobothrium sebago* (Cestoda) in the mid small intestine of gulls (Meyer & Vik, 1963), *Dispharynx nasuta* (Nematoda) in the crop of partridges (Madsen, 1952), *Heterakis gallinarum* (Nematoda) in the caeca of fowl (Roberts, 1937), and *Polymorphus minutus* (Acanthocephala) in the posterior small intestine of ducks (Crompton & Harrison, 1965). What features define the habitats

occupied by these helminths in birds and by others in other vertebrate hosts (Crompton, 1973)? As indicated, our research took a different direction in the mid 1970's so we never completed the project we had originally envisioned. We did, however, have a collection of drawings of the alimentary tract of a large number of individual birds. Since the anatomy of higher vertebrates is unlikely to have changed much during this time under natural conditions we hope that observations made during this survey will still be relevant and of interest. We want to make these drawings accessible to future investigators exploring aspects of avian anatomy and digestion.

The digestive system in birds

(Numbers in the text identify birds in our survey listed below)

The digestive system transforms food into the components that can be absorbed across the intestinal wall into the blood stream to provide the nutrients needed to support life. Foods contain simple and complex carbohydrates, fats, proteins, smaller organic compounds (vitamins) and mineral elements. Foods are digested with the aid of enzymes secreted in various parts of the alimentary tract thereby releasing simple sugars from carbohydrates, amino acids from proteins, and free fatty acids from fats. Foods must be macerated to make components accessible to enzymes, seed coats need to be opened, and lipids need to be emulsified. The normal food taken by a species may contain material that is not a substrate for the digestive enzymes present. In such cases the digestive system contains specialized areas where microorganisms assist in digestion, producing small molecules that can also be absorbed. Microorganisms are usually found in the lower digestive tract and in *organs* such as the caeca or, in rare cases, the crop where bacterial activity also produces absorbable short chain fatty acids. The overall length of the digestive system seems to reflect the relative ease of digestion of the usual food supply. The small intestines of some birds are quite long and so may provide an environment where microorganisms can digest food components. Examination of the drawings of the various alimentary tracts[1] shows wide variation in the structure and size of the caeca. The form and function of avian caeca were the subject of an extensive review by Clench & Mathias (1995). The observations in our drawings are consistent with theirs. In many species the caeca are long and well developed. In others, however, they are small (Song Thrush, 98), rudimentary (Magnolia Warbler, 111) or absent (Belted Kingfisher, 66). The three herons in our survey (5, 6 and 7) each had one small caecum.

Generally, species feeding on fibrous diets appear to have large caeca, an observation consistent with their role being that as a site of microbial digestion. Red Grouse (22) feed largely on shoots of young heather, a plant with relatively little readily digestible carbohydrate (Moss & Parkinson , 1972). Grouse possess two long caeca where considerable microbial fermentation promotes the release of energy from this highly fibrous food. Clench & Mathias cite data where caecal length was much longer in several species of Ptarmigan, Grouse and Quail in winter, when less digestible food was available, than in spring when young succulent plants

1 See: Anatomical drawing, beginning on page 11.

emerged as food. Thus caecal size can be variable depending on the diet consumed. In a study conducted using caecectomized young chickens, the apparent digestibility of a heat damaged protein was much less than in intact chickens (Nesheim & Carpenter, 1967). DWTC helped in the surgical preparation of the caecectomized chickens thereby marking the beginning of our many years of collaborative research. According to Clench and Mathias, the small caeca of many species contain mainly lymphatic tissue, suggesting some immunological function as yet not well understood. Interestingly, in the domesticated fowl (27), there is histological evidence for the presence of lymphatic tissue at the point where the caeca join the junction between the small intestine and the coprodeum (PJ Clarke, Personal communication).

In the Hoatzin, crop fermentation been shown to assist in the digestion of fibrous foods (Godoy-Vitorino, Ley *et al,* 2008). This means that, as in ruminant mammals, the digestion of complex carbohydrates begins before that of protein. The crop in several families of birds has rather significant storage capacity (30,51,129) and may together with the oesophagus facilitate food storage in times when a bird can exploit a plentiful food supply. The Gray Heron (5) had an oesophagus containing several small fish that were probably caught when the bird found a shoal. The Canada Goose (8) has been described as having significant amounts of food in its oesophagus after prolonged feeding, perhaps another illustration of temporary storage. In other birds the crop may serve this function. The Hooded Vulture (19) has to seize food quickly against competition from other scavengers. While the Pelican (3) has specialized mouth parts for this purpose.

The ventriculus (gizzard) is a muscular structure prominent in seed eaters and those birds that consume plant material. Ventricular contractions macerate and grind foods exposing them to digestive enzymes. Some birds ingest grit that remains in the ventriculus and helps maceration. In the ventriculus food is mixed with the acid and proteolytic enzymes secreted by the proventriculus and the digestive process continues. In most of the alimentary tracts in our survey we have been able to identify the pancreas and gall bladder along with associated ducts. The pancreas secretes several enzymes essential for digestion and the gall bladder is a reservoir for bile. Bile is important in the digestion and absorption of fat. Some details of the anatomy of the gall bladder and associated ducts have been illustrated by Crompton & Nesheim (1972).

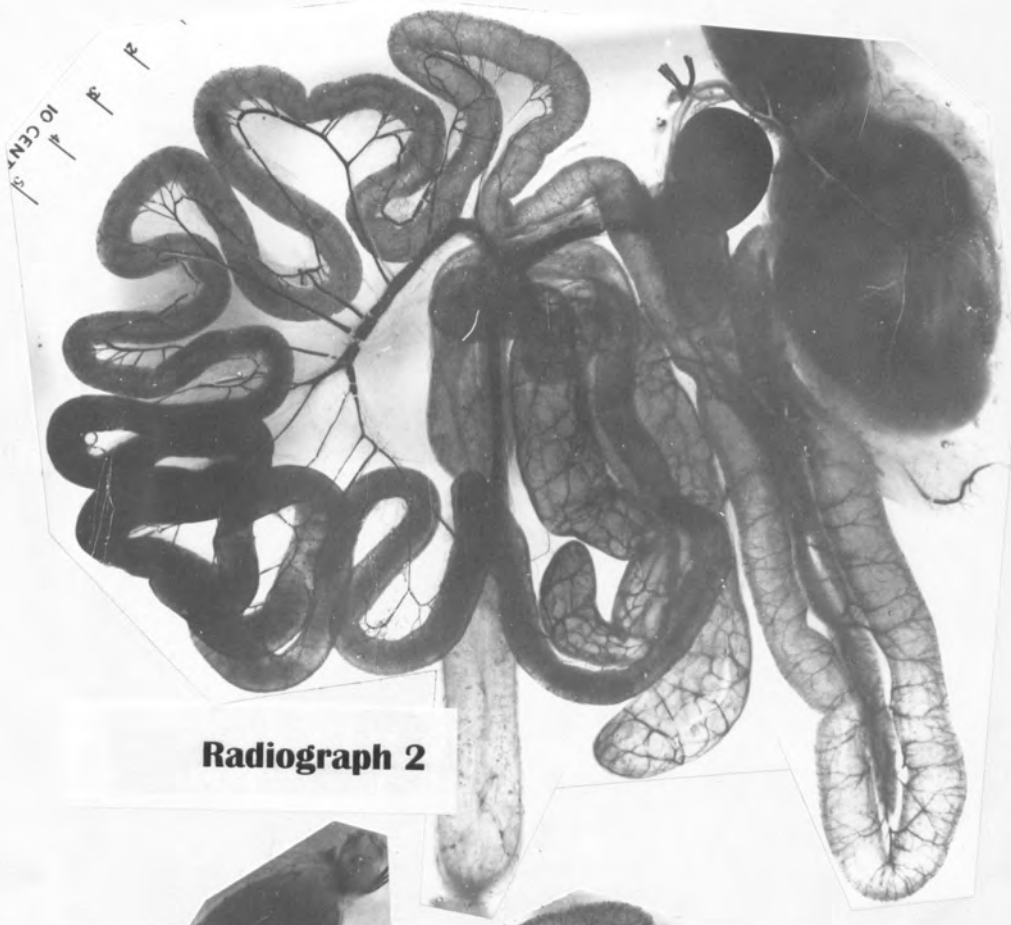
Overall in healthy warm-blooded vertebrates, the efficient digestion of normal food is influenced by the length of the alimentary tract and the rate of intestinal motility in different parts of the tract. These factors, in operation with the activity of digestive and absorptive processes, lead to varying chemical conditions along the alimentary tract. Such changes help to define the habitats occupied by different species of helminth. The tract is easily entered and stages that will infect the next host are easily dispatched. Host digestion products and intestinal tissues provide food for helminths. In mammals, and probably birds, the tract seems to be an immunoprivileged site for helminths in the lumen; the full range of lymphocytes and antibodies have not been found in the alimentary tract.

Observations on the alimentary tract of the Domesticated Fowl *(Gallus gallus, 27)*

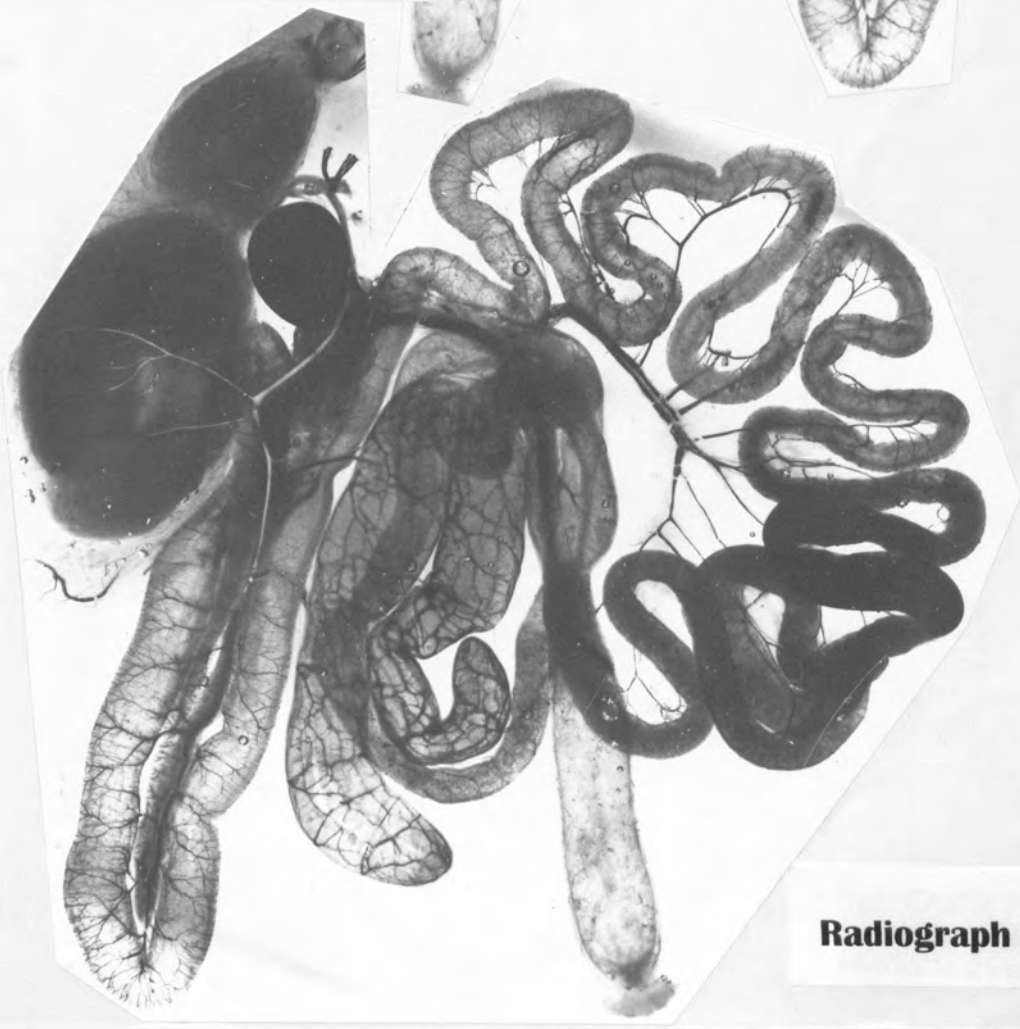
The tract of the fowl was investigated as an aid to help with the interpretation of our survey of the tracts of wild birds. Some results are already available in Crompton (1976) and Crompton & Nesheim (1976). In Crompton (1976) preparations leading to figs 1 and 2 were facilitated by Andre Bensadoun; the drawings were made by Paula DiSanto Bensadoun.

Radiographs

Radiographs 1, 2, 3 and 4 (below) were obtained on 5th December 1974 through the expertise and skill of Roger Akester, Sub -department of Veterinary Anatomy, University of Cambridge. Anesthesia was induced in an adult female fowl by brachial intravenous injection of 2ml urethane/Nembutal mixture. The right femoral artery was cannulated and more Nembutal was added to achieve euthanasia. A solution of micropaque was gradually introduced (1 ml up to 4ml at a time) and radiographs were taken with the bird arranged in various positions. Exposures ranged from 52KV 32ms to 40KV 10m AS. The procedure revealed the vascular supply to the alimentary tract crucial for maintenance, growth, tissue repair, digestion, absorption and helminths. These radiographs do not show the tract *in situ*.



Radiograph 2

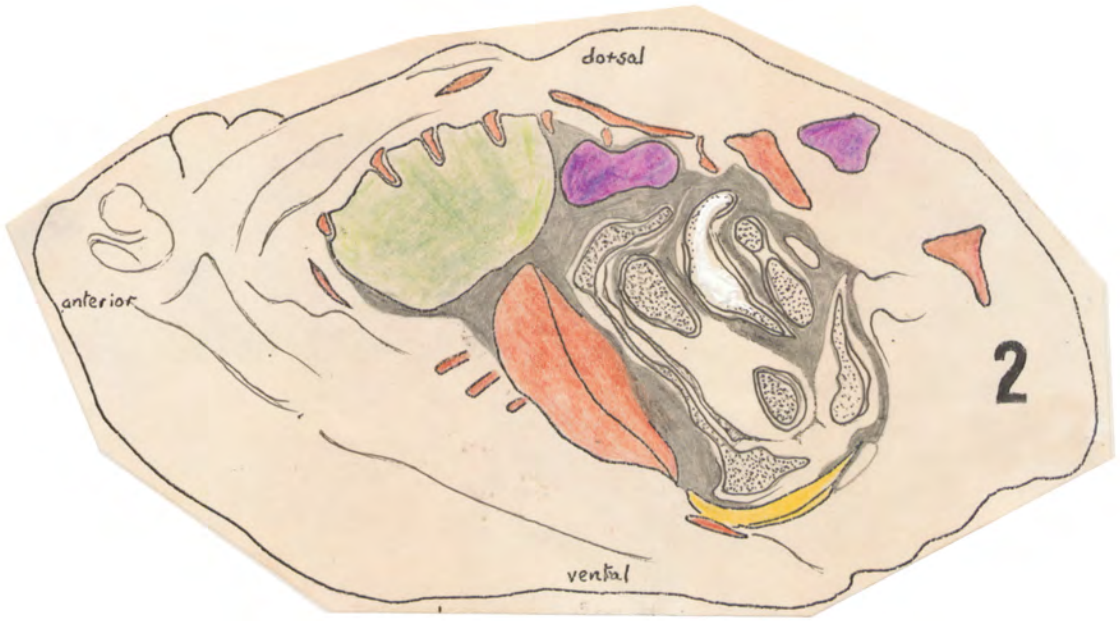


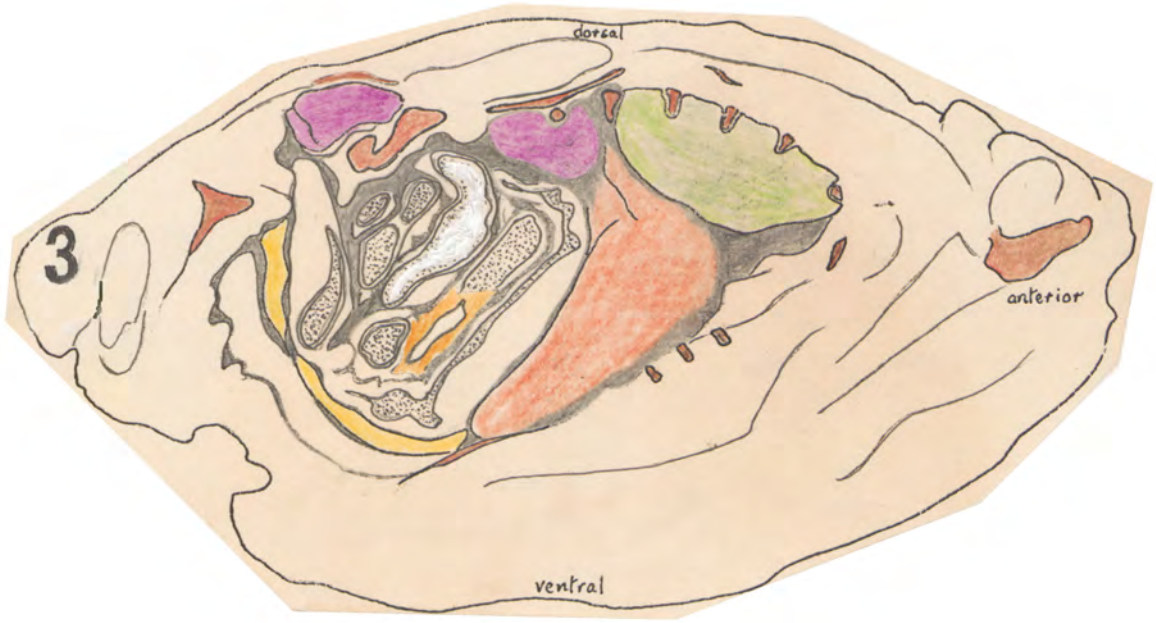
Radiograph 3

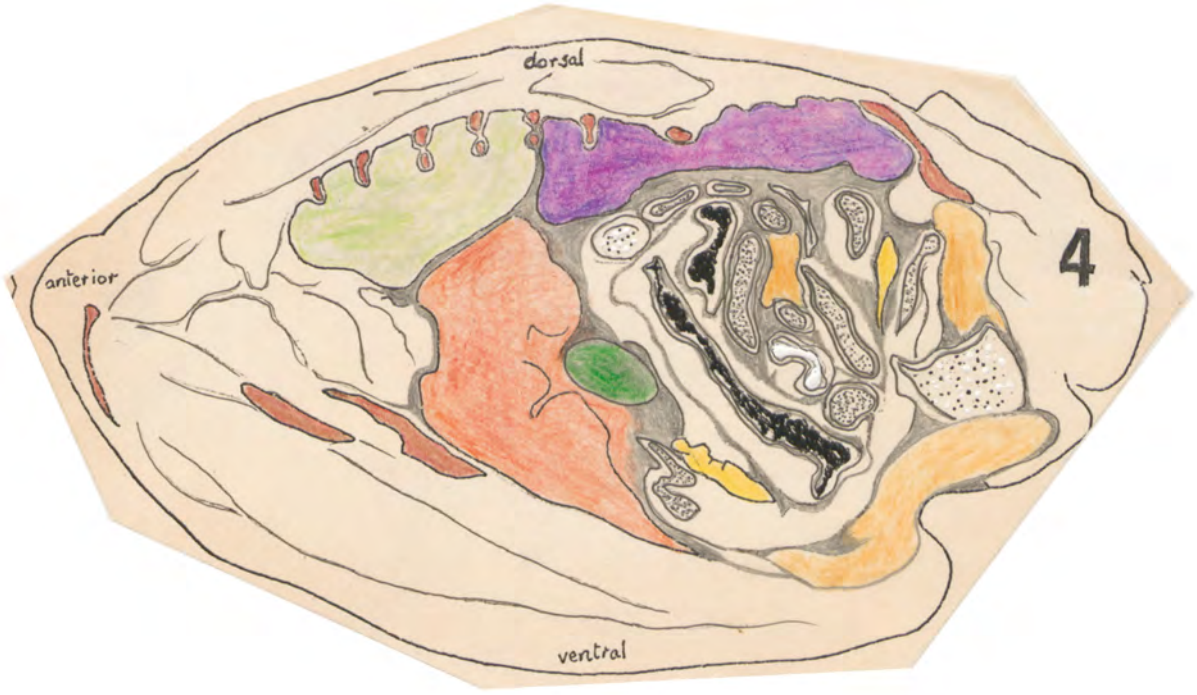
Radiograph 4

Sagittal sections

Sagittal sections 2, 3, 4, 5, 6, 7, 8 and 9 (below) were obtained through the skill and expertise of John Cash, Department of Anatomy, University of Cambridge. Anesthesia was induced in a young fowl on 24th October 1974. Black ink was injected in to one caecum and white ink in to the other followed by euthanasia. The body was skinned, limbs were removed and lateral incisions were made to enable 5% formalin to penetrate. After 24h, the preparation was submerged in a solution of 10% formic acid made up in 10% formalin to decalcify bone. Eight days later, after washing for 8h in running water, the preparation was immersed for periods of 24h each in 5%, 10% and 20% gelatine, cooled and fixed overnight in 5% formalin. Finally, the preparation was held in a jig and sections about 1cm thick were cut with a sharp knife. Drawings were made and colored to identify tissues and organs visible on one side of each section. Section 1 was discarded.




3
dorsal
anterior
ventral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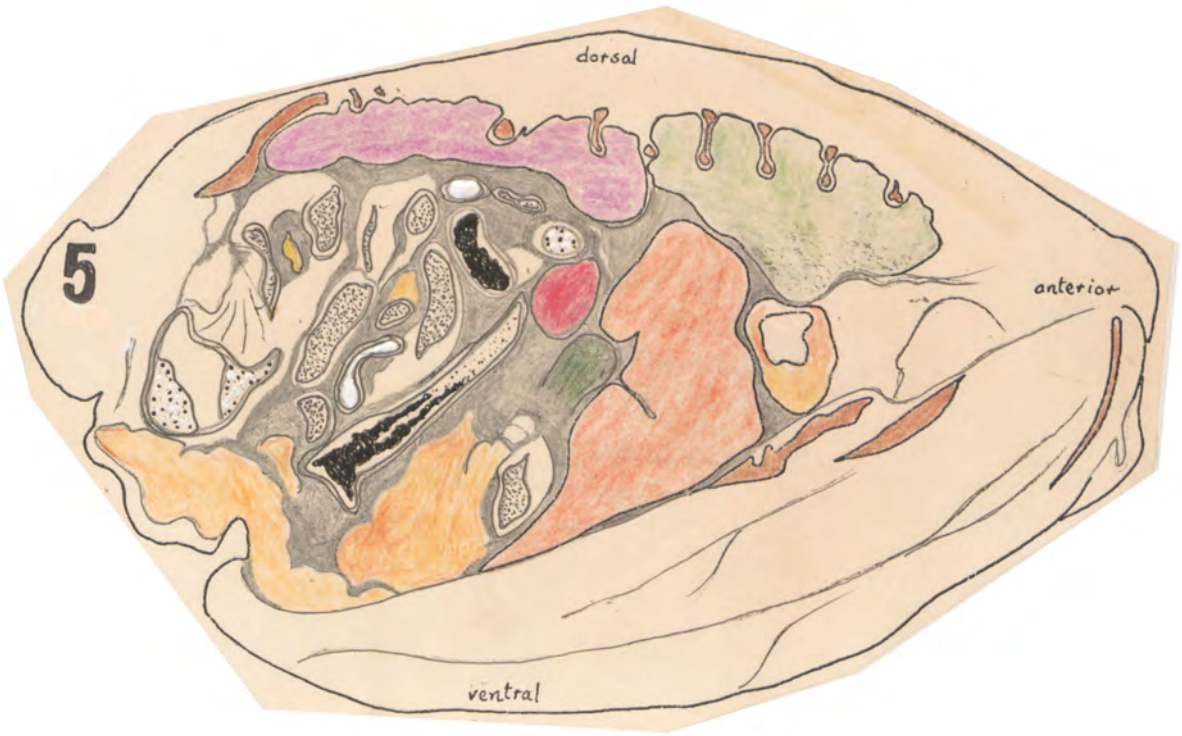
5
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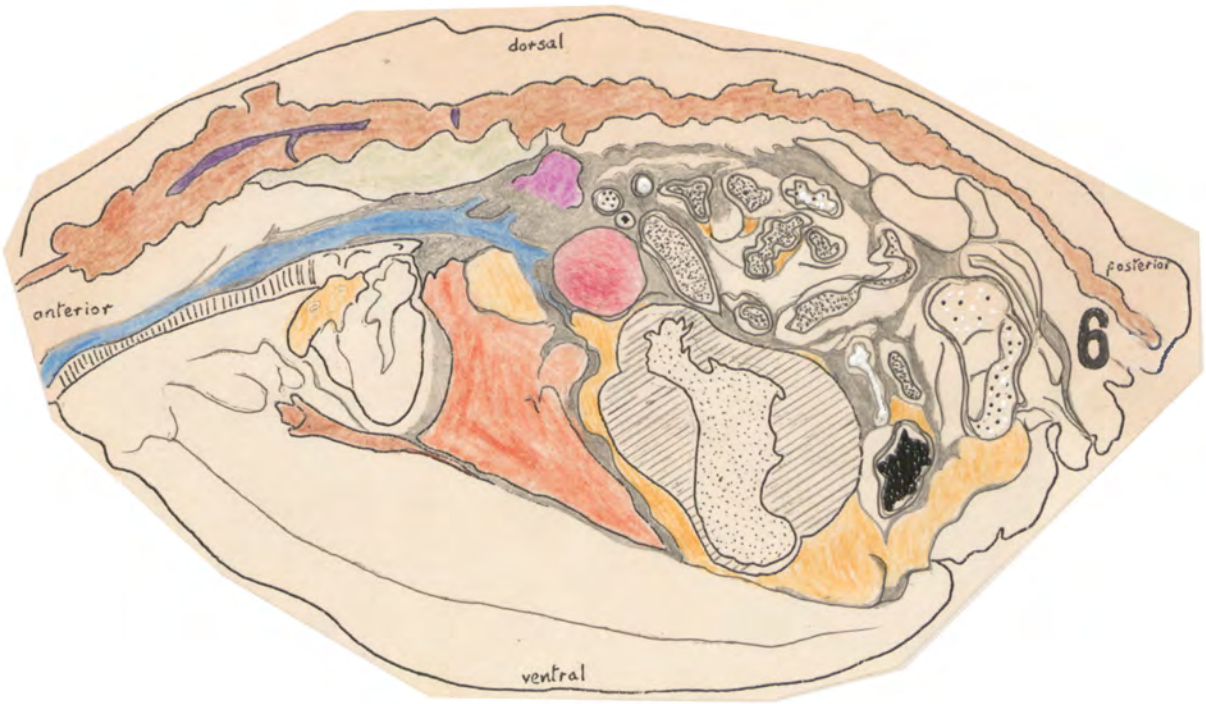
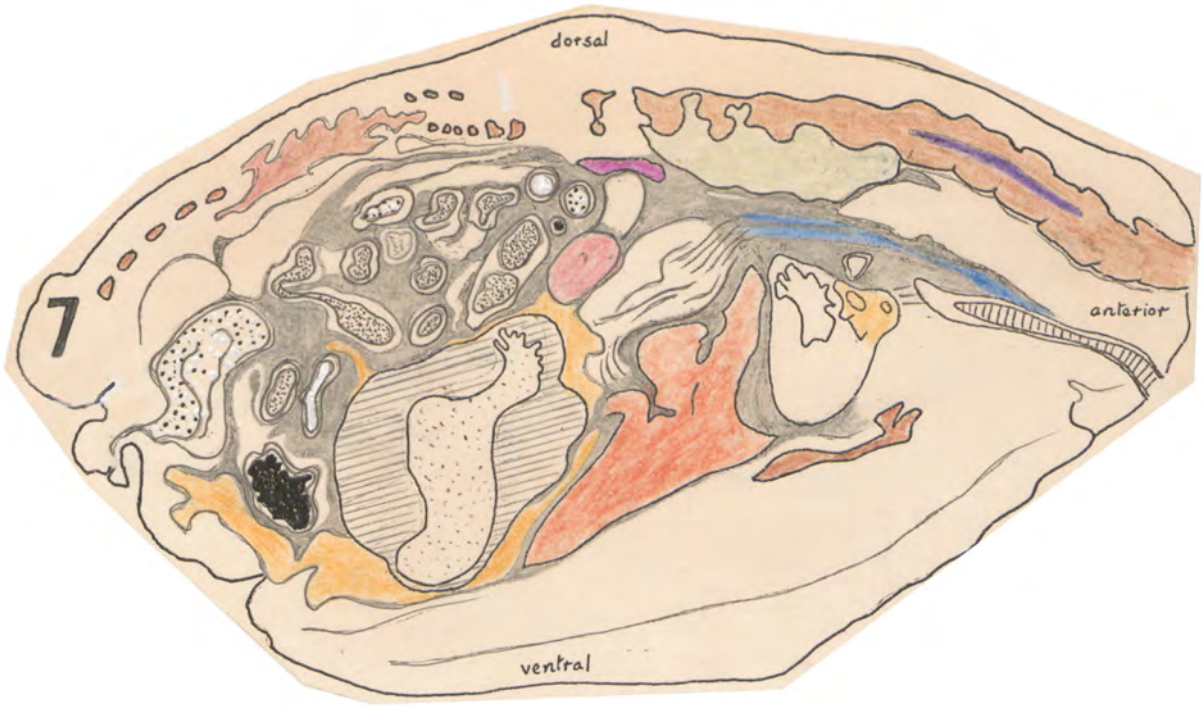

dorsal
anterior
posterior
6
ventral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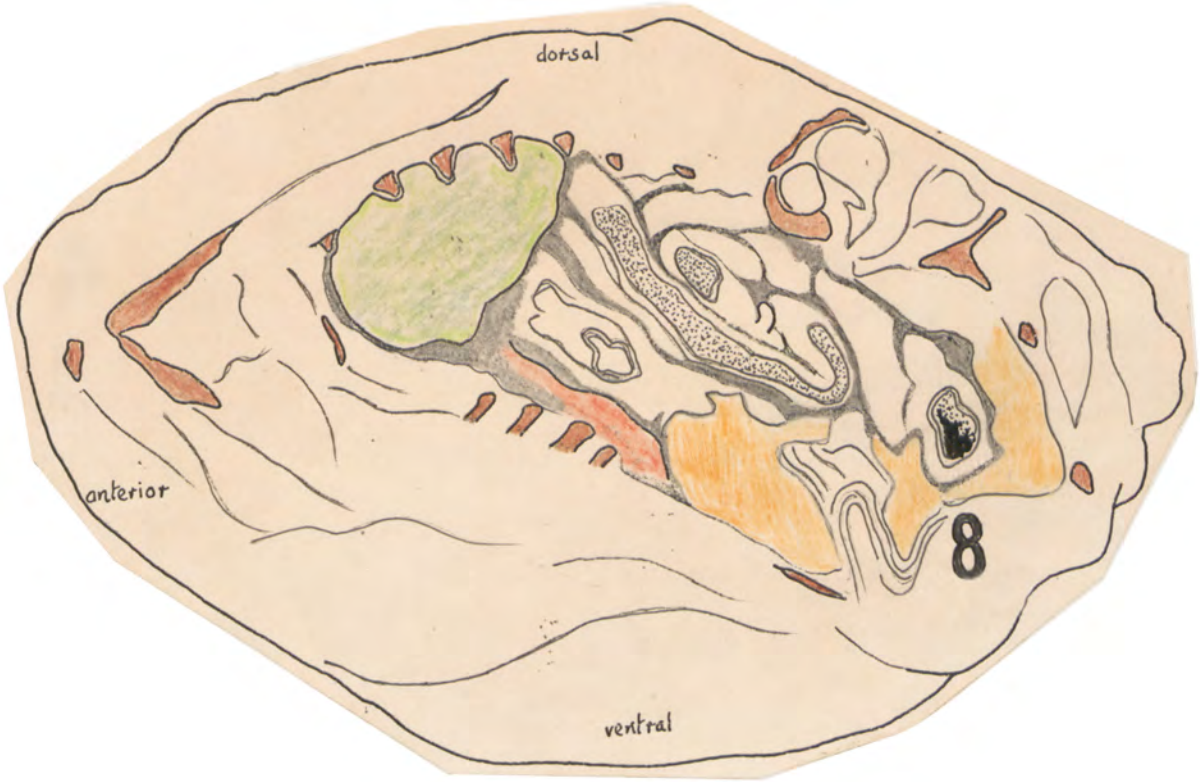
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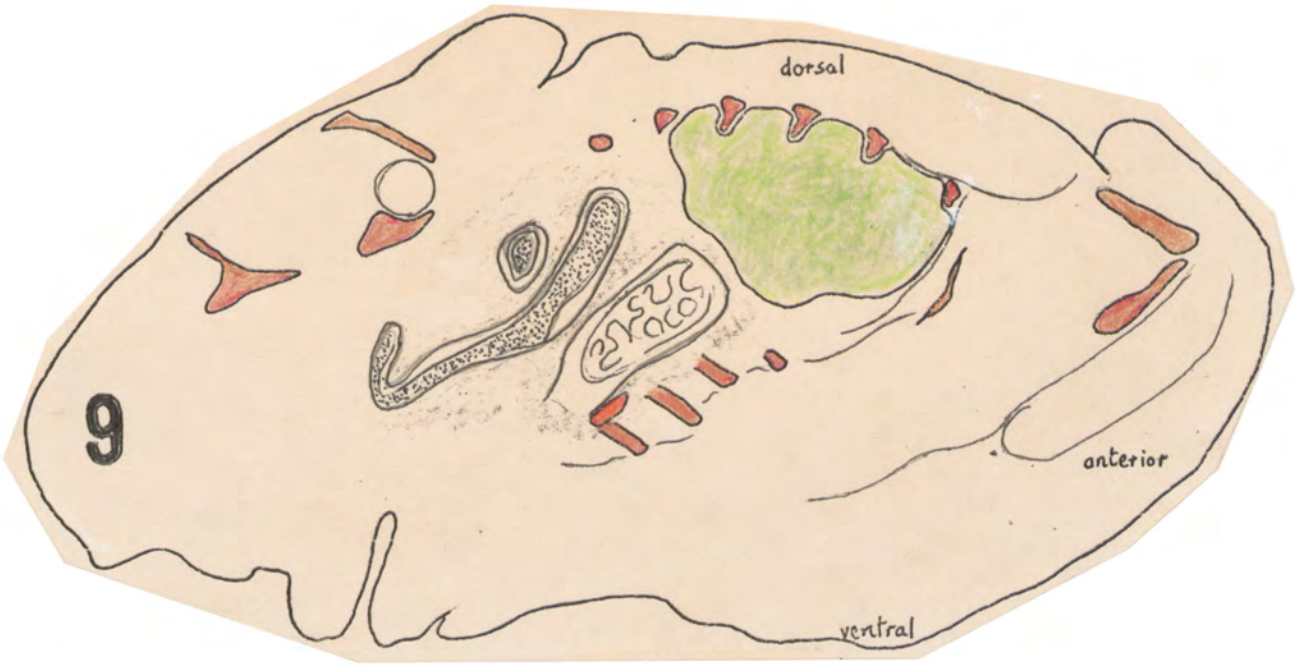
anterior
8
ventral


9
dorsal
anterior
ventral

Anatomical drawings

Species of bird examined in the survey are arranged according to the check list published by Clements (1974)

The alimentary tracts of 151 birds from 52 families were examined and drawn during the survey. Of these, 7 were domesticated birds (10[1], 11, 27, 31, 52, 53 and 134), 3 were not identified as far as species (15, 52 and 53); one of these was a hybrid duck (15). Three pairs of birds (46 & 47, 77 & 78 and 146 & 147) were included. The rock doves (46 & 47) permitted comparison between wild and feral representatives, the swallows (77/78) between the same species in different continents, and the tree sparrows (146/147) between two individuals from similar habitats.

1. Most specimens were handled under license from the New York State Department of Environmental Conservation (Bureau of Wildlife) and the UK Nature Conservancy Council.

2. Dates on the drawings may indicate when the bird was obtained, when it reached the donor or when its tract was displayed and examined. The location of a specimen does not always indicate its origin.

3. The provenance of each specimen and how it was examined are set out with its drawing. Many specimens had been stored frozen. These were thawed at room temperature in an aqueous solution of 5% formaldehyde (formalin). Some were photographed with a Polaroid camera for the scale.

4. Colleagues who provided specimens are named on the drawings. We are extremely grateful to them for their help and their cooperation that made possible this set of observations.

5. Some of the names used by Clements (1974) may have changed since his publication. Taxonomists regularly revise classifications hence changes. Nevertheless, despite any differences, we have found Clements' list to be most useful.

6. John James Audubon in his *The Birds of America* (published between 1840 and 1844) included descriptive comments about the alimentary tracts of many birds; sometimes he provided drawings. We have added to our drawings pages in the Dover edition (1967) where reproductions of his drawings can be seen. For example, in the case of the Ruffed Grouse (23), JJA v5, p82 directs to Audubon's drawing in volume 5, page 82 of the Dover edition (1967).

7. We have added brief dietary notes based on information from the Internet, on entries in *A Dictionary of Birds* (Campbell & Lack, 1985), on field guides available to bird watchers, or on observations made during dissection.

8. Related anatomical information can be found in the work of Gadow (1879).

1 These numbers refer to the following drawings.

NON-PASSERINES

Note: If using the Adobe Acrobat Reader (or the full version) with the digital version (PDF), click a numbered entry below to scroll to the associated drawing; use the "previous view" command to return.

Tinamidae (Tinamous)

1 *Crypturellus soui* (Little Tinamou)

2 *Eudromia elegans* (Elegant Crested Tinamou)

Pelicanidae (Pelicans)

3 *Pelicanus roseus* (White Pelican)

Phalacrocoracidae (Cormorants)

4 *Phalacrocorax auritus* (Double-crested Cormorant)

Ardeidae (Herons)

5 *Ardea cinerea* (Gray Heron)

6 *Ardea herodias* (Great Blue Heron)

7 *Nictanassa violacea* (Yellow-crowned Night Heron)

Anatidae (Ducks and Geese)

8 *Branta canadensis* (Canada Goose)

9 *Anser brachyrhynchus* (Pink-footed Goose)

10 *Anser anser domesticus* (Domesticated Goose)

11 *Anos platyrhynchos* (Mallard; domesticated Kharki Campbell)

12 *Anas rubripes* (American Black Duck)

13 *Anas americana* (American Wigeon)

14 *Bucephalus clangula* (Common Goldeneye)

15 *Anas sp.* (Hybrid duck)

Accipitridae (Hawks)

16 *Buteo jamaicensis* (Red-tailed Hawk)

17 *Buteo buteo* (Common Buzzard)

18 *Aquila rapax* (Tawny Eagle)

19 *Necrosyrtes monarchus* (Hooded Vulture)

Falconidae (Falcons)

20 *Falco mexicanus* (Prairie Falcon)

21 *Falco tinnunculus* (Eurasian Kestrel)

Tetraonidae (Grouse)

22 *Lagopus scoticus* (Red Grouse)

23 *Bonansa umbellus* (Ruffed Grouse)

Phasianidae (Pheasants)

24 *Colinus virginianus* (Bobwhite/Bobwhite Quail)

25 *Perdix perdix* (Partridge)

26 *Coturnix coturnix* (European [Japanese] Quail)

27 *Gallus gallus* (Red Jungle Fowl/Domesticated Fowl)

28 *Phasianus colchicus* (Ring-necked Pheasant)

29 *Pavo cristatus* (Common Peafowl/Peacock)

Numididae (Guinea fowl)

30 *Numida meleagris* (Tufted Guinea fowl)

Meleagrididae (Turkeys)

31 *Meleagris galloparvo* (Common Turkey)

Gruidae (Cranes)

32 *Grus canadensis* (Sandhill Crane)

Rallidae (Rails)

33 *Gallinula chloropus* (Moorhen)

34 *Fulica atra* (Coot)

Charadriidae (Plovers)

35 *Vanellus vanellus* (Northern Lapwing)

36 *Charadrius semipalmatus* (Semi-palmated Plover)

Scolopacidae (Sandpipers)

37 *Capella gallinago* (Common Snipe)

38 *Scolopax rusticola* (Eurasian Woodcock)

39 Philohela minor (American Woodcock)

40 *Calidris minutilla* (Least Sandpiper)

41 *Calidris alpina* (Dunlin)

Stercorariidae (Skuas)

42 *Catharacta skua* (Great Skua "Bonxie")

Laridae

43 *Larus argentatus* (Herring Gull)

44 *Larus marinus* (Great Black-backed Gull)

45 *Laus ridibundus* (Black-headed Gull)

Columbidae (Pigeons and Doves

46 *Columba livia* (Rock Dove from India)

47 *Columba livia* (Rock Dove: Ferai Pigeon/City Pigeon)

48 *Zenaida macroura* (Mourning Dove)

49 Streptopelia turtur (Turtle Dove)

50 *Claravis pretiosa* (Blue Ground Dove)

Psittacidae (Parrots)

51 *Melopsittacus undulates* (Budgerigar)

52 *Agapornis spp.* (Love Bird)

53 *Loriculus spp.* (Hanging Parrot)

Musophagidae (Turacos)

54 *Crinifer leucogaster* (White-bellied Go-away Bird)

Cuculidae (Cuckoos)

55 *Coccyzus americanus* (Yellow-billed Cuckoo)

Tytonidae (Barn Owls)

56 *Tyto alba* (Barn Owl)

Strigidae (Owls)

57 *Otus asio* (Screech Owl)

58 *Bubo virginianus* (Great Horned Owl)

59 Athene noctua (Little Owl)

60 *Ciccaba virgata* (Mottled Owl)

61 *Strix aluco* (Tawny Owl)

Caprimulgidae (Nightjars)

62 *Chordeiles minor* (Common Nighthawk)

Trochilidae (Hummingbirds)

63 *Eugenes fulgens* (Magnificent [Rivoli's] Hummingbird)

64 *Archilochus colubris* (Ruby-throated Hummingbird)

Coliidae (Colies)

65 *Colius striatus* (Speckled Mousebird)

Alcedinidae (Kingfishers)

66 *Ceryle alcyon* (Belted Kingfisher)

67 Alcedo atthis (Common Kingfisher)

Upupidae (Hoopoes)

68 Upupa epops (Common Hoopoe)

Indicatoridae (Honeyguides)

69 Indicator minor (Lesser Honeyguide)

Picidae (Woodpeckers)

70 *Colaptes auratus* (Yellow-shafted Flicker/Common Flicker)

71 *Sphyrapious varius* (Yellow-bellied Sapsucker)

72 *Dendrocopos minor* (Lesser Spotted Woodpecker)

73 Dendrocopos pubescens (Downy Woodpecker)

PASSERIFORMES (Perching Birds)

Dendrocolaptidae (Woodcreepers)

74 *Xiphorhynchus flavigaster* (Ivory-billed Woodcreeper)

Tyrannidae (Tyrant Flycatchers)

75 *Megarhynchus pitangua* (Boat-billed Flycatcher)

Alaudidae (Larks)

76 *Alauda avensis* (Eurasian Skylark)

Hirundinidae (Swallows)

77 *Riparia riparia* (Bank Swallow/Sand Martin)-North America

78 *Riparia riparia* (Sand Martin/Bank Swallow)-Europe

79 *Hirundo rustica* (Swallow/Barn Swallow)

Corvidae (Crows and Jays)

80 *Cyanocitta aristata* (Blue Jay)

81 *Pica pica* (Black-billed Magpie/Magpie)

82 *Corvus monedula* (Jackdaw)

83 *Corvus frugilegus* (Rook)

84 *Corvus corone* (Carrion Crow)

85 *Corvus corax (ruficollis)* (Common Raven)

Paridae (Titmice)

86 *Parus atricapillus* (Black-capped Chickadee)

87 *Parus caeruleus* (Blue Tit)

Certhidae (Creepers)

88 *Certhia familiaris* (Tree Creeper/Brown Creeper)

Troglodytidae

89 *Telmatodytes palustris* (Long-billed Marsh Wren)

90 *Troglodytes troglodytes* (Wren)

Mimidae (Mocking Birds and Thrashers)

91 *Dumetella carolinensis* (Catbird)

92 *Toxostoma rufum* (Brown Thrasher)

Turdidae (Thrushes)

93 *Erithacus rubecula* (Robin)

94 *Catharus fuscescens* (Veery)

95 *Catharus ustulata* (Swainson's Thrush)

96 *Catharus mustelina* (Wood Thrush)

97 *Turdus merula* (Blackbird)

98 *Turdus philomelos* (Song Thrush)

99 *Turdus migratorius* (American Robin)

Sylviidae (Old World Warblers)

100 *Regulus satrapa* (Golden-crowned Kinglet)

Prunellidae (Hedge Sparrows)

101 *Prunella modularis* (Dunnock/Hedge Sparrow)

Bombycillidae (Waxwings)

102 *Bombycilla cedorum* (Cedar Waxwing)

Laniidae (Shrikes)

103 *Lanius excubitor* (Northern Shrike)

Sturnidae (Starlings)

104 *Sturnus vulgaris* (Common Starling)

Nectariniidae (Sunbirds)

105 *Anthreptes longuemarei* (Violet-backed Sunbird)

Vireonidae (Vireos)

106 *Vireo solitarius* (Solitary Vireo)

107 *Vireo olivaceus* (Red-eyed Vireo)

Parulidae (American Wood-Warblers)

108 *Mniotilta varia* (Black-and White Warbler)

109 *Vermivora ruficapilla* (Nashville Warbler)

110 *Dendroica petechia* (Yellow Warbler)

111 *Dendroicam agnolia* (Magnolia Warbler)

112 *Dendroica caerulescens* (Black-throated Blue Warbler)

113 *Dendroica virens* (Black-throated Green Warbler)

114 *Dendroica fusca* (Blackburnian Warbler)

115 *Dendroica pensylvanica* (Chestnut-sided Warbler)

116 *Dendroica castanea* (Bay-breasted Warbler)

117 *Dendroica striata* (Blackpoll Warbler)

118 *Seiurus aurocapillus* (Oven Bird)

119 *Geothlypis trichas* (Yellowthroat)

120 *Setophaga ruticilla* (American Redstart)

Icteridae (Troupials)

121 *Molothrus ater* (Brown-headed Cowbird)

122 *Quiscalus quiscula* (Common Grackle)

123 *Agelaius phoenicius* (Red-winged Blackbird)

124 *Icterus galbula* (Baltimore Oriole)

125 *Sturnella magna* (Eastern Meadowlark)

126 *Dolichonyx oryzivorus* (Bobolink)

Thraupidae (Tanagers)

127 *Euphonia hirudinacea* (Yellow-throated Euphonia)

128 *Piranga olivacea* (Scarlet Tanager)

Ploceidae (Weaverbirds)

129 *Passer domesticus* (House Sparrow)

Fringillidae (Grosbeaks, Finches, Sparrows and Buntings)

130 *Cardinalis cardinalis* (Cardinal)

131 *Pheuticus ludovicianus* (Rose-breasted Grosbeak)

132 *Passerina cyanea* (Indigo Bunting)

133 *Fringilla coelebs* (Chaffinch)

134 *Serinus canaria domestica* (Eurasian Canary)

135 *Hesperiphona vespertina* (Evening Grosbeak)

136 *Pyrrhula pyrrhula* (Common Bullfinch)

137 *Carpodacus mexicanus* (House Finch/Linnet)

138 *Carduelis chloris* (Greenfinch)

139 *Carduelis carduelis* (Goldfinch)

140 *Emberiza citronella* (Yellowhammer)

141 *Emberiza schoeniclus* (Reed Bunting)

142 *Arremonops rufivirgatus* (Olive Sparrow)

143 *Ammospiza martima* (Seaside Sparow)

144 *Ammospiza caudacuta* (Sharp-tailed Sparrow)

145 *Junco hyemalis* (Slate-colored Junco)

146 *Spizella arborea* (Tree Sparrow)

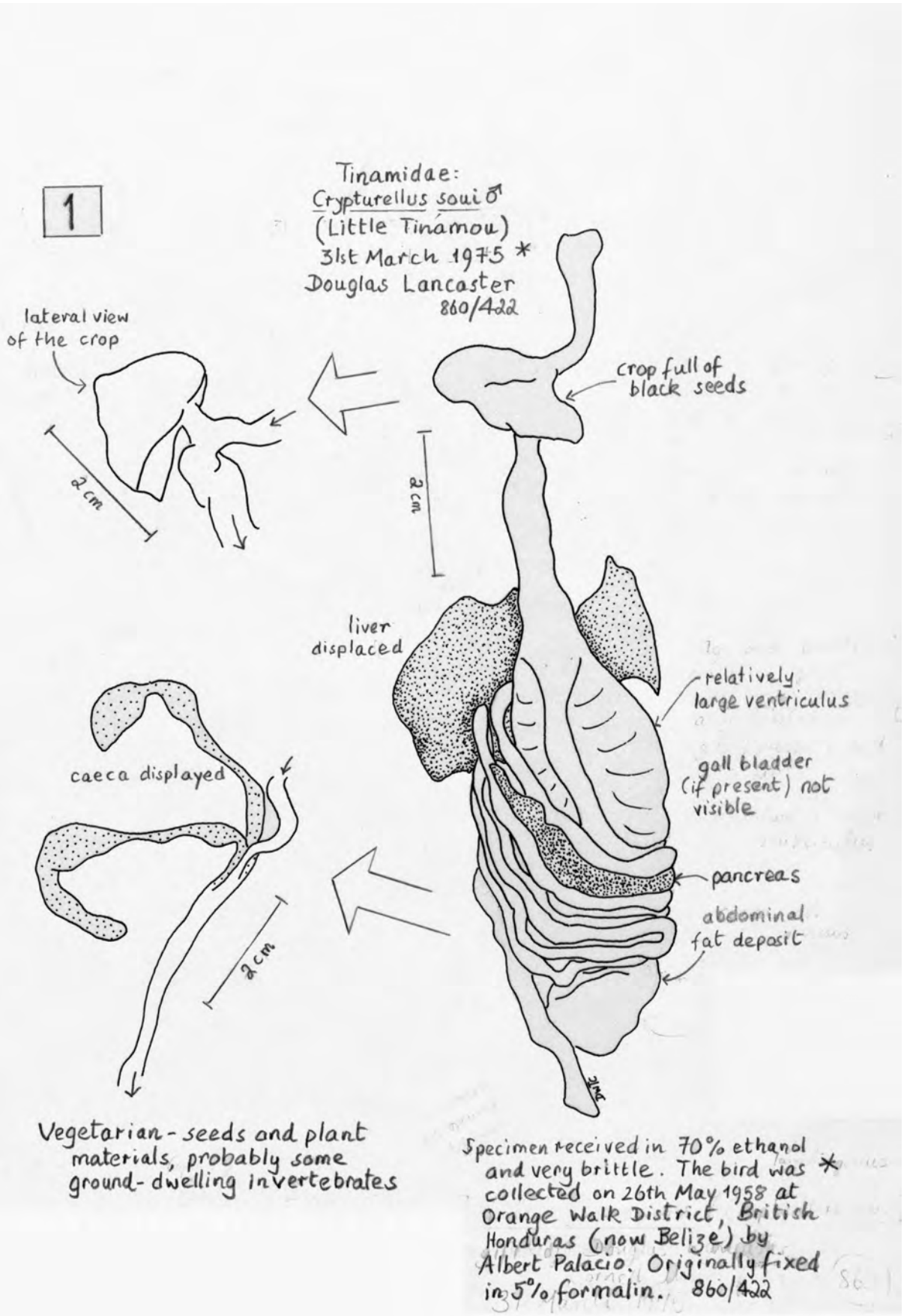
147 *Spizella arborea* (Tree Sparrow)

148 *Zonotrichia leucophrys* (White-crowned Sparrow)

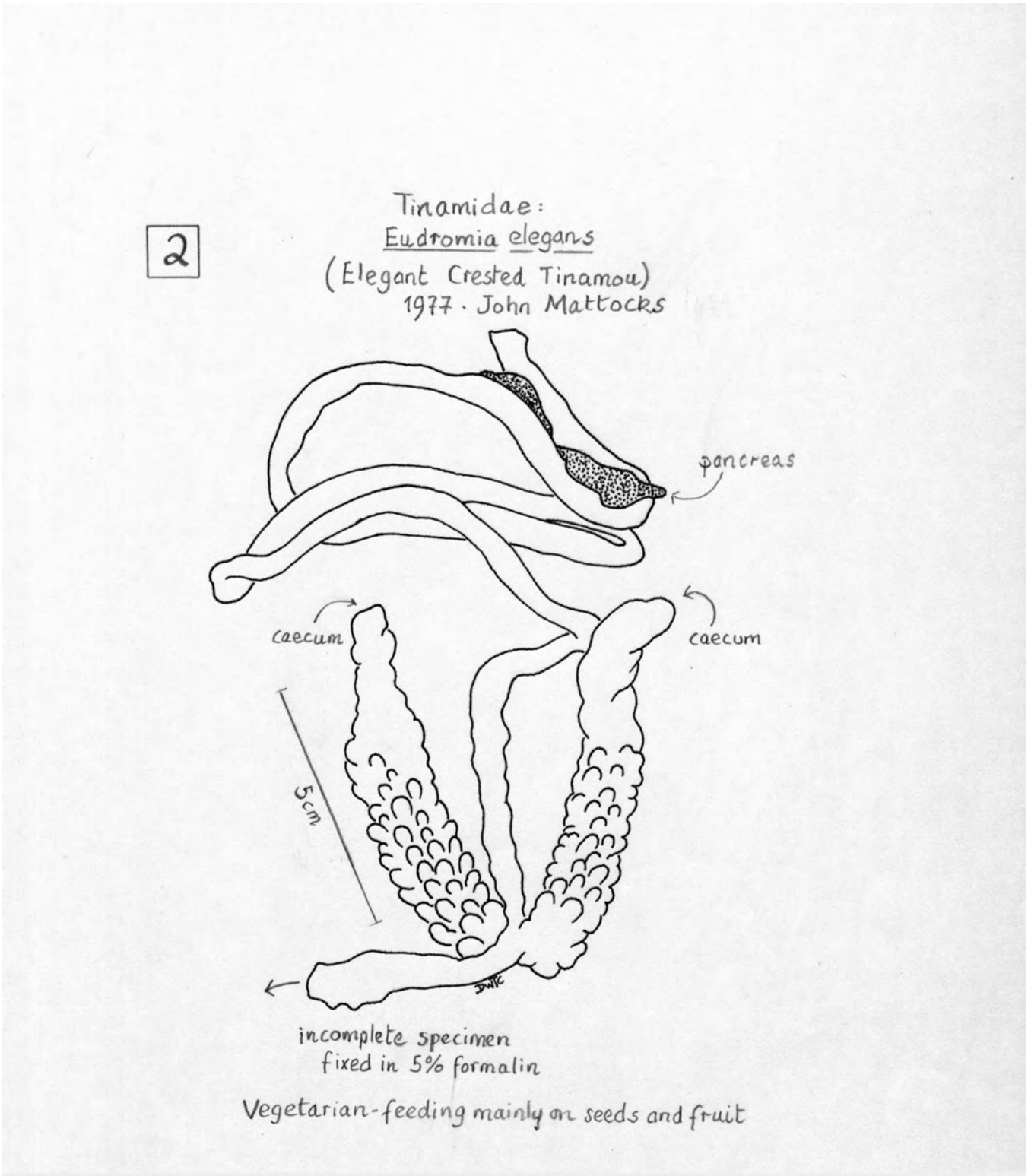
149 *Melospiza lincolni* (Lincoln's Sparow)

150 *Melospiza georgiana* (Swamp Sparrow)

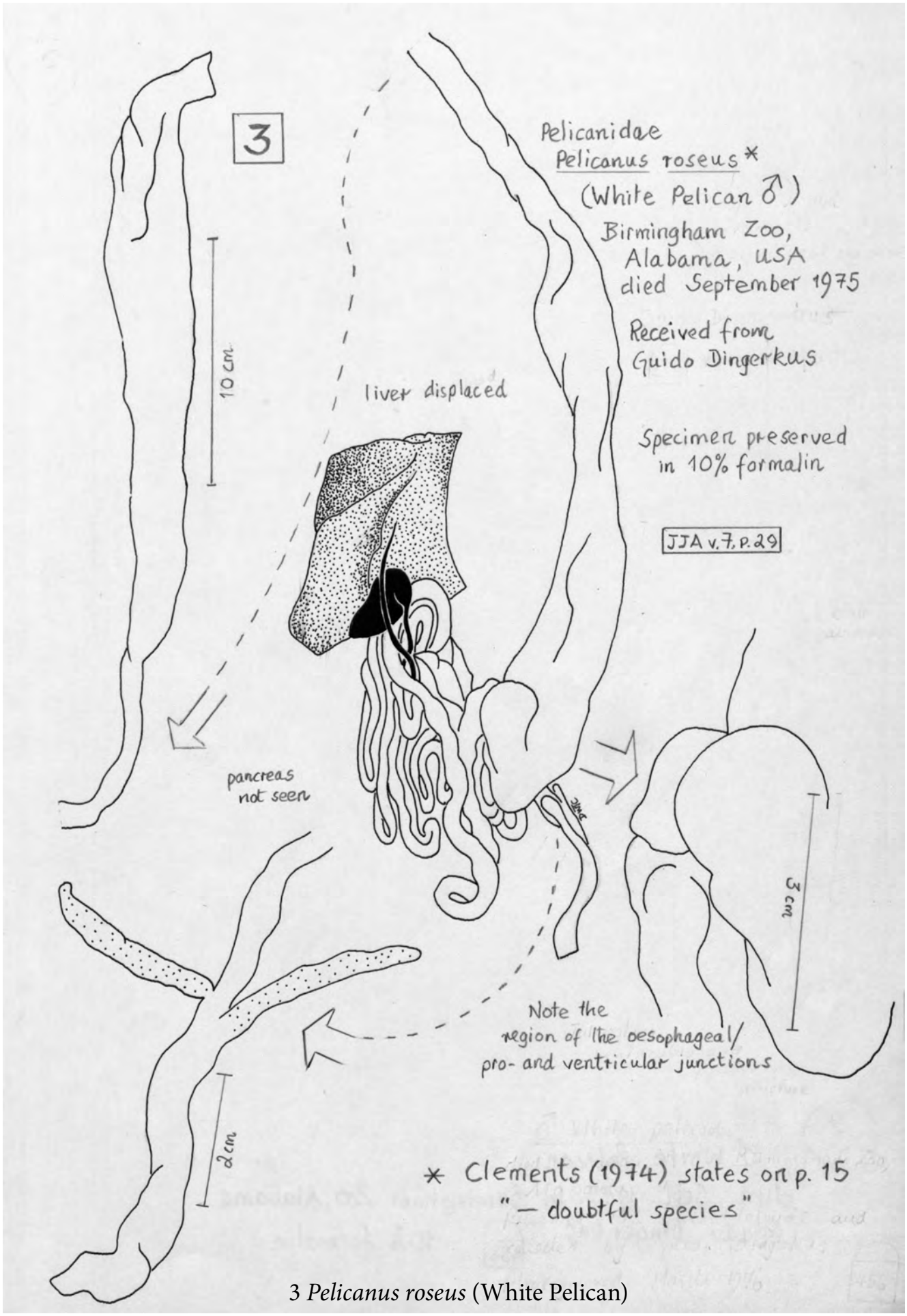
151 *Melospiza melodia* (Song Sparrow)



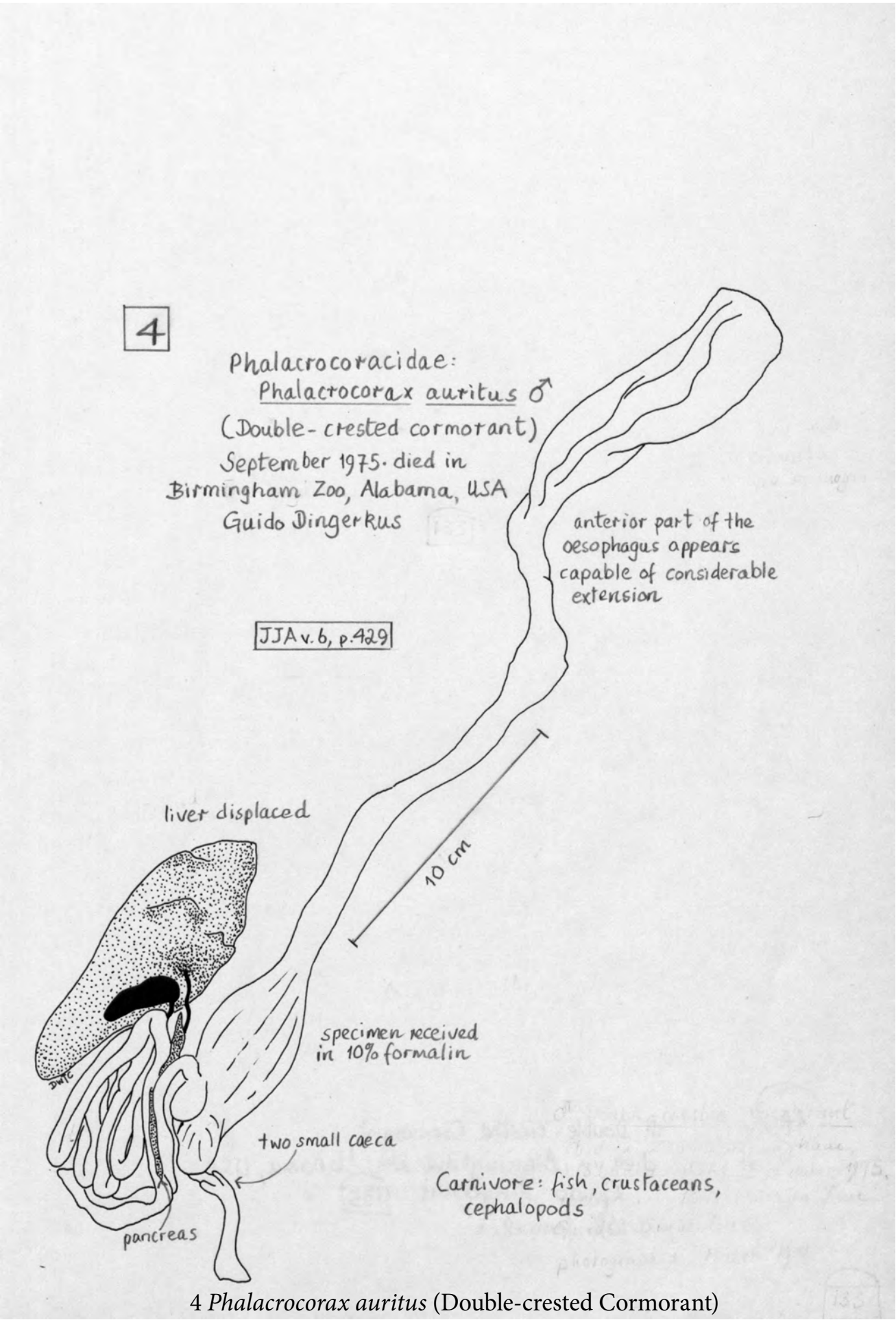
1 *Crypturellus soui* (Little Tinamou)



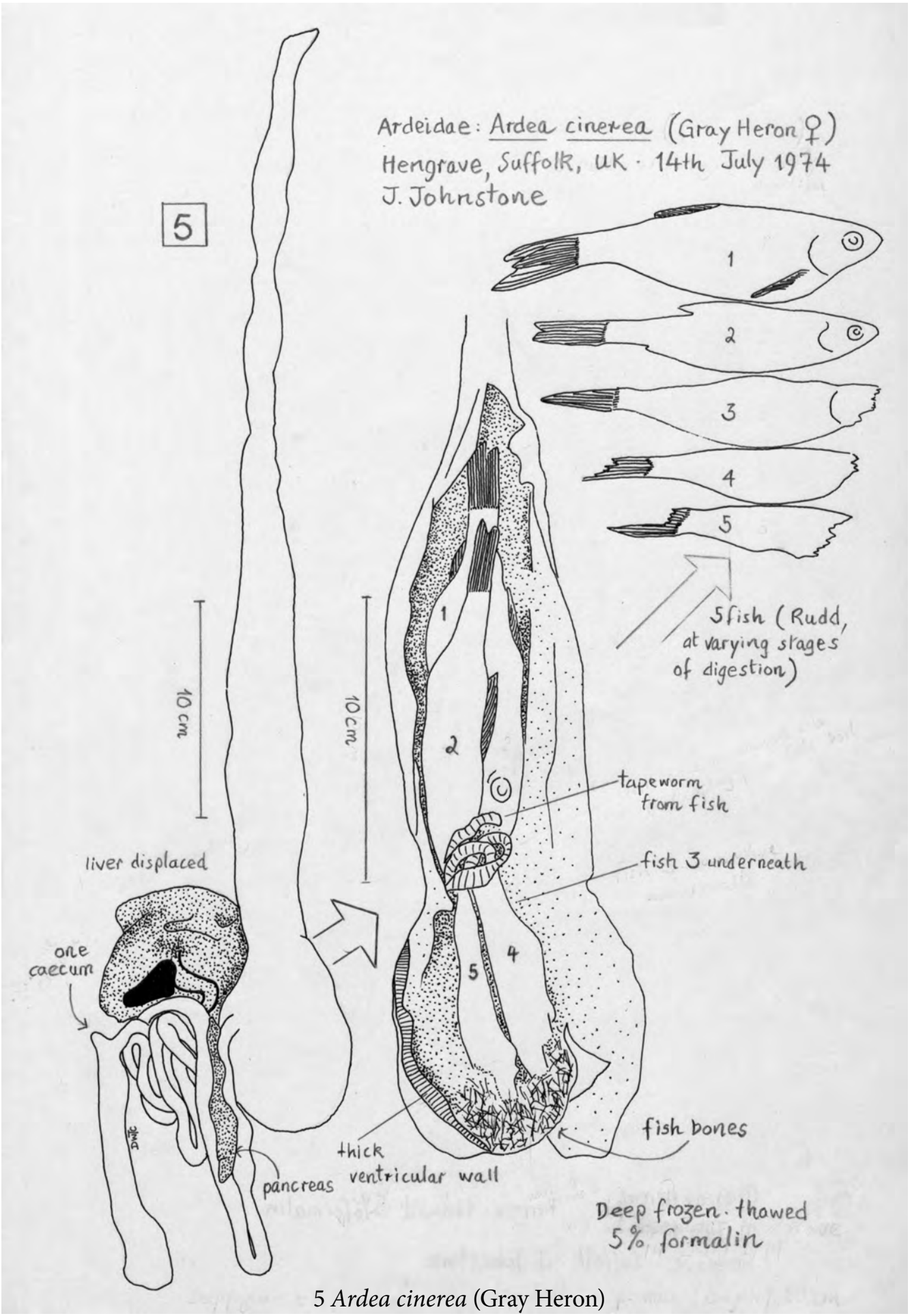
2 *Eudromia elegans* (Elegant Crested Tinamou)



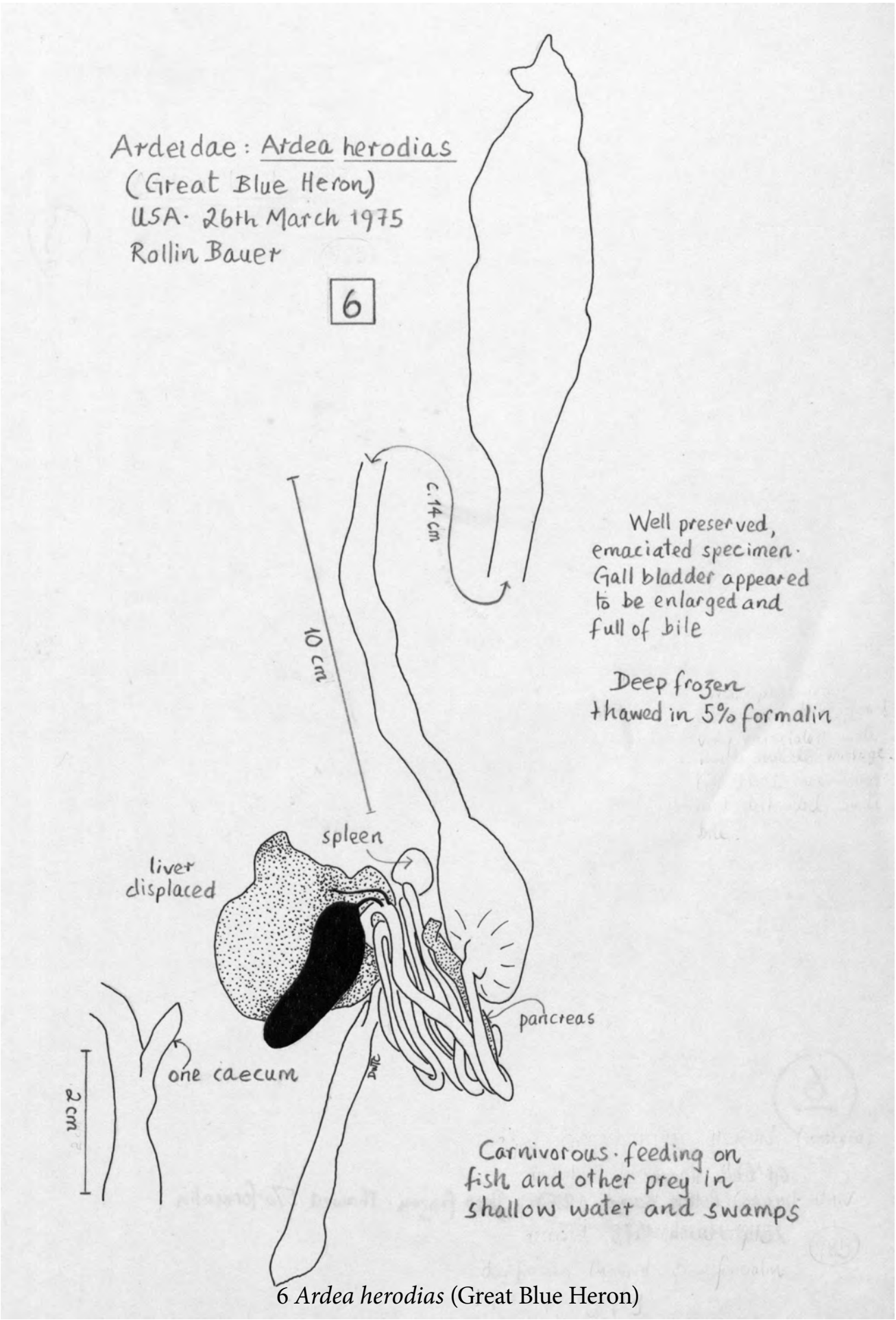
3 *Pelicanus roseus* (White Pelican)



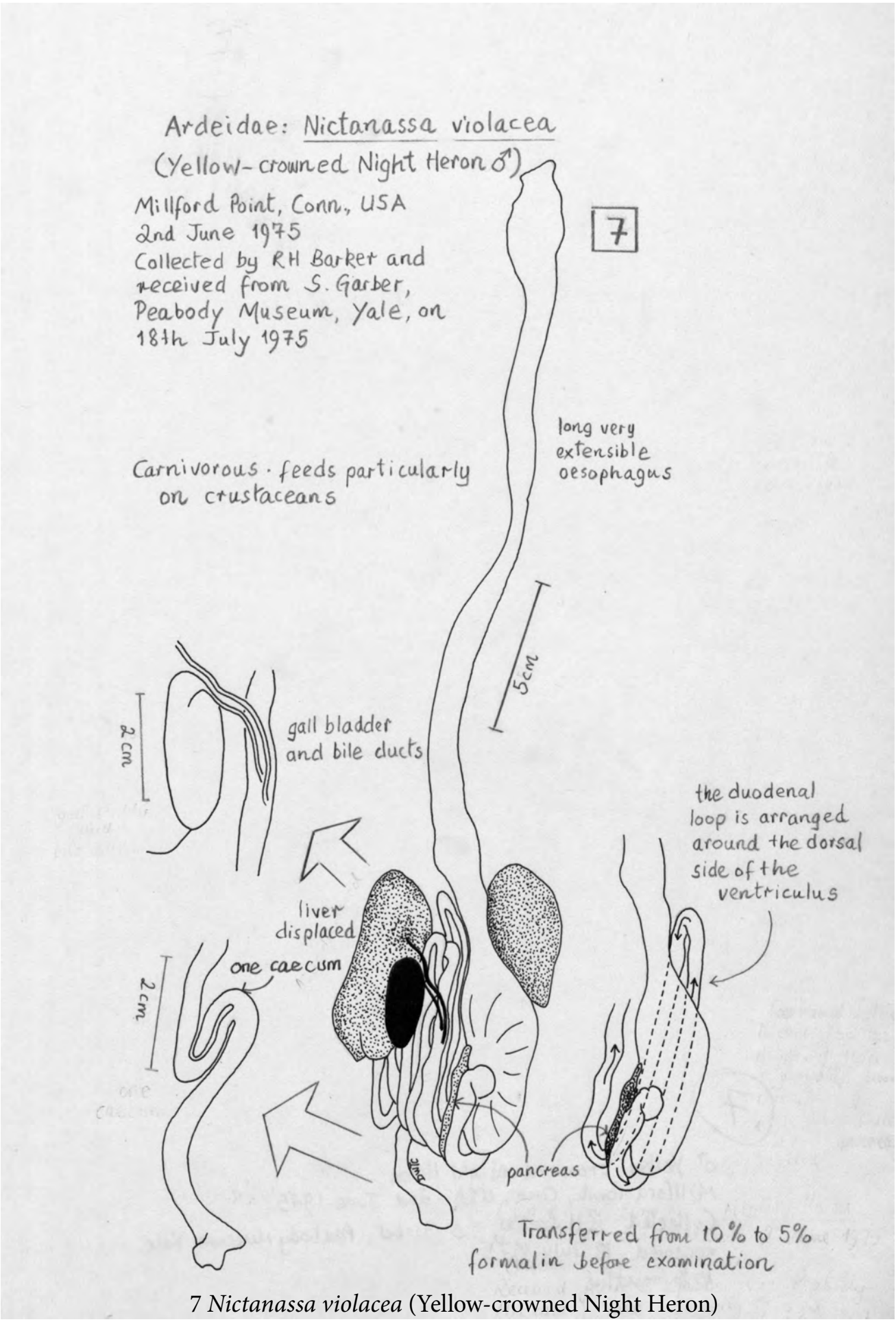
4 *Phalacrocorax auritus* (Double-crested Cormorant)



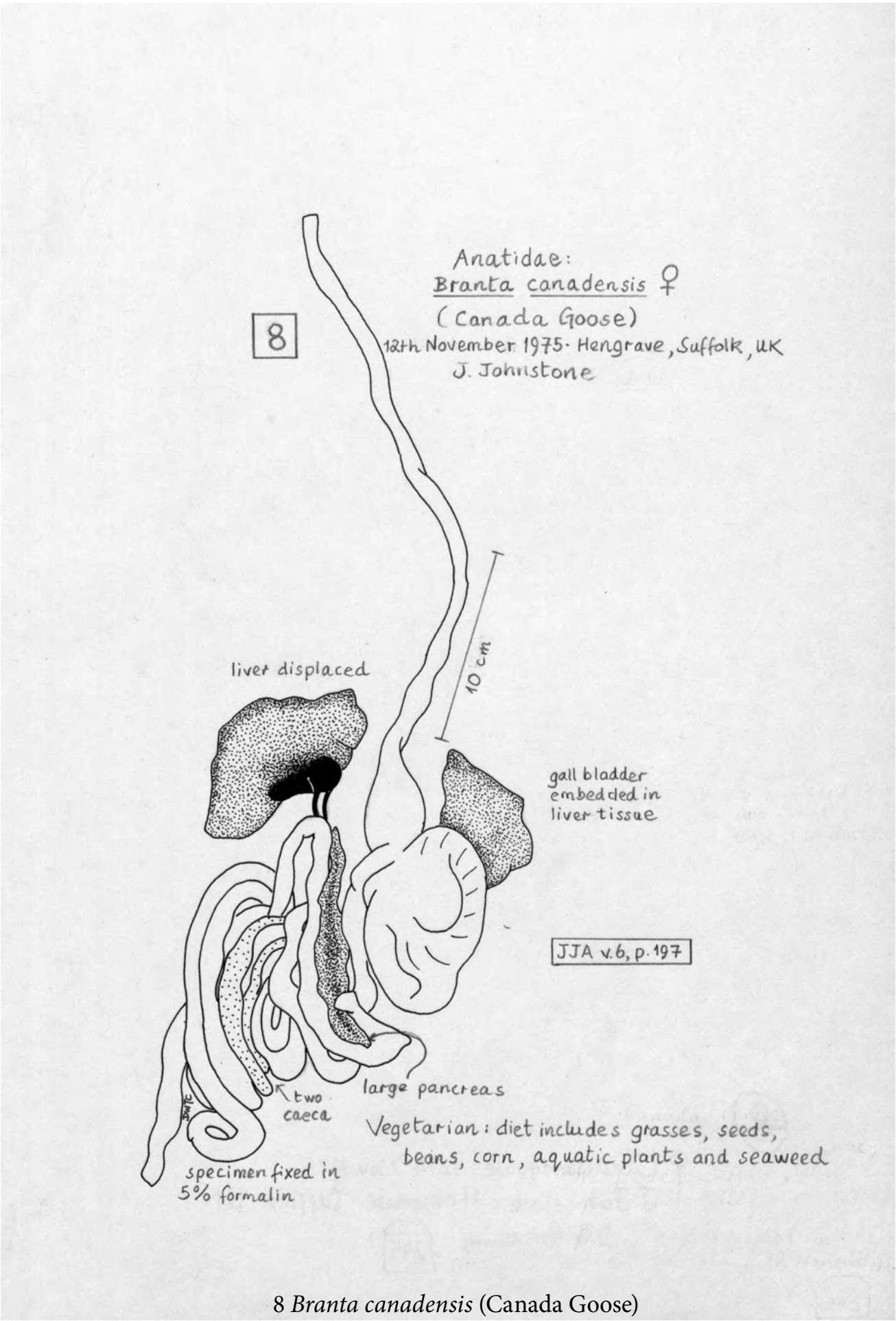
5 *Ardea cinerea* (Gray Heron)



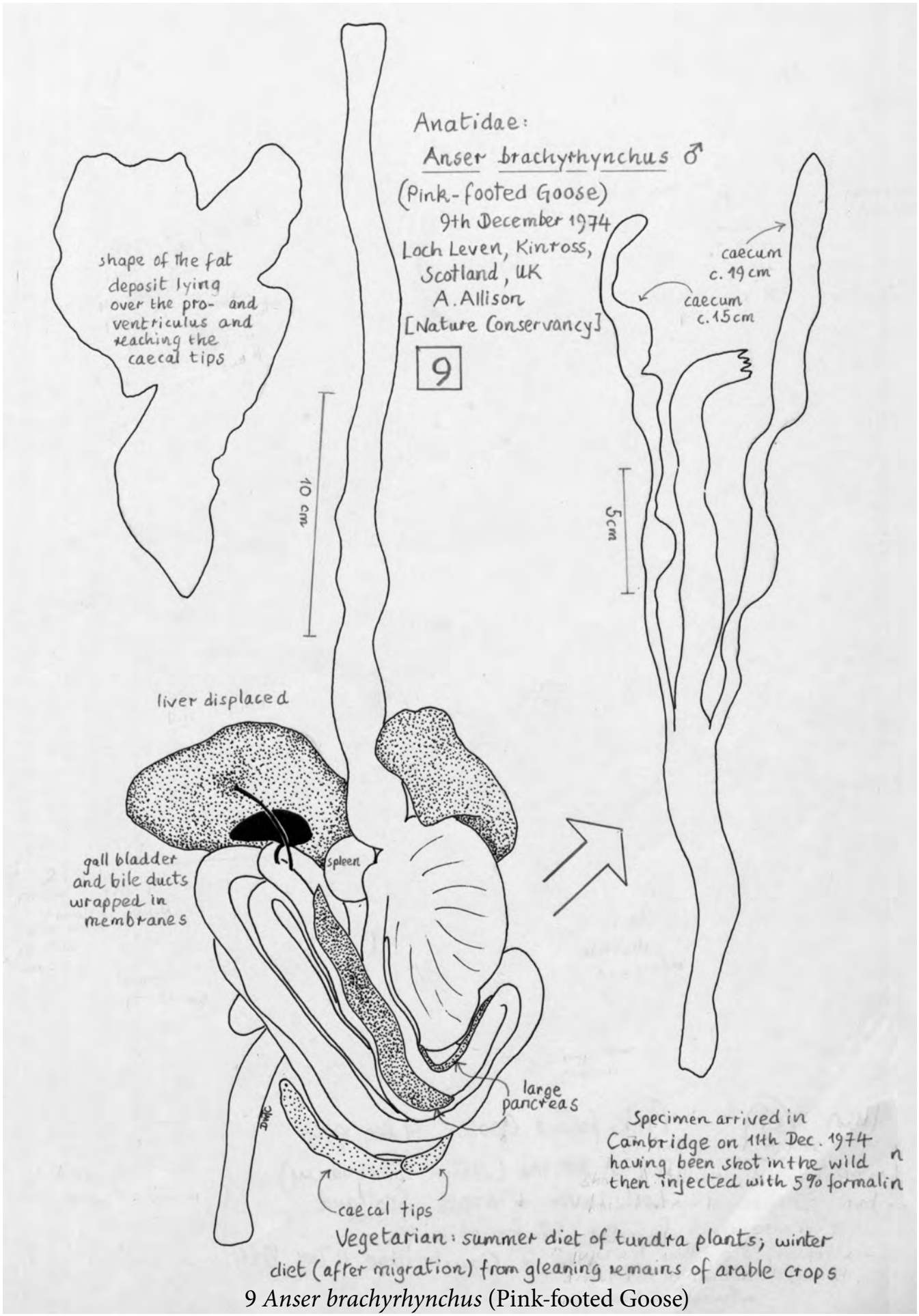
6 *Ardea herodias* (Great Blue Heron)



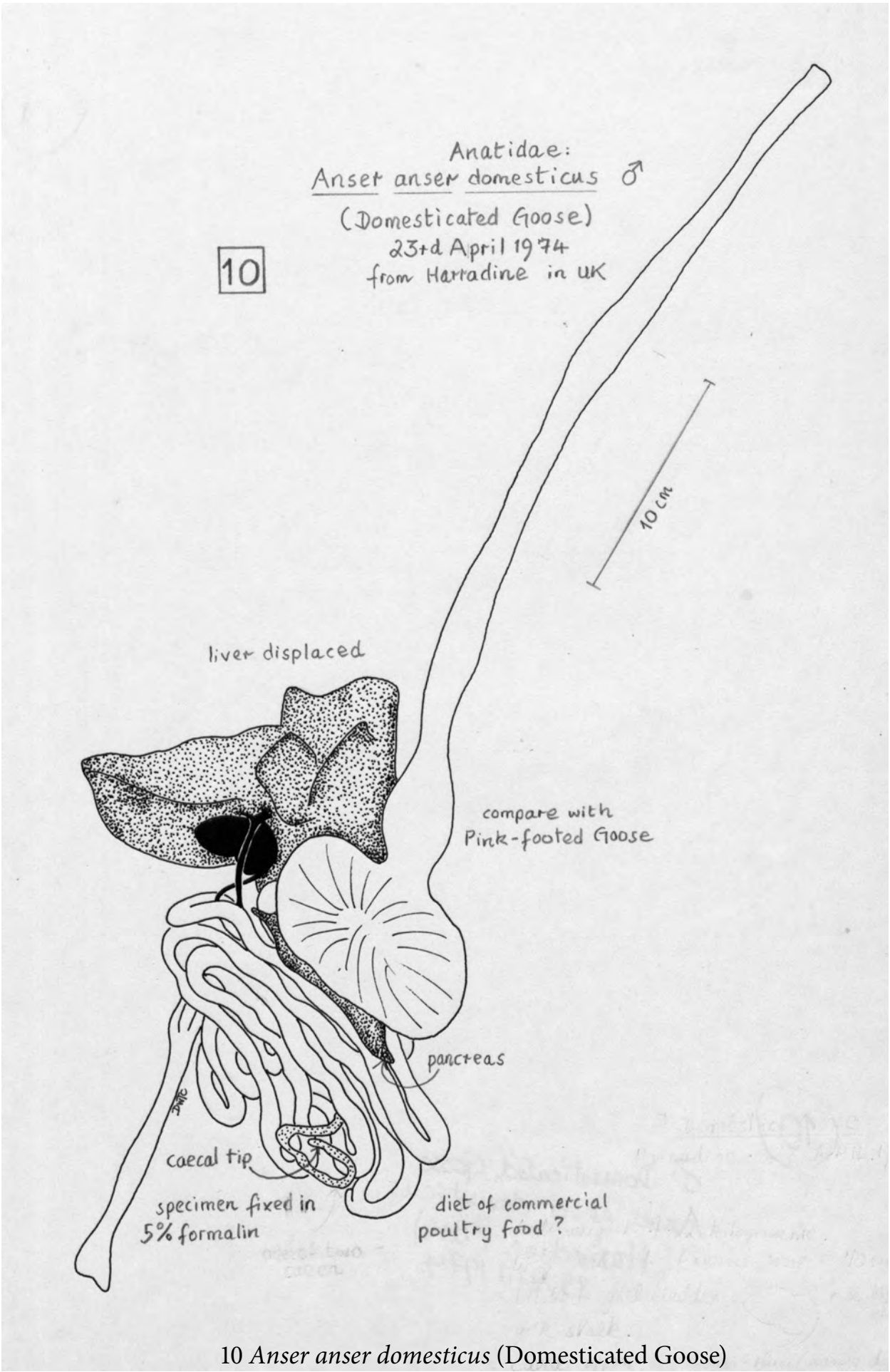
7 *Nictanassa violacea* (Yellow-crowned Night Heron)



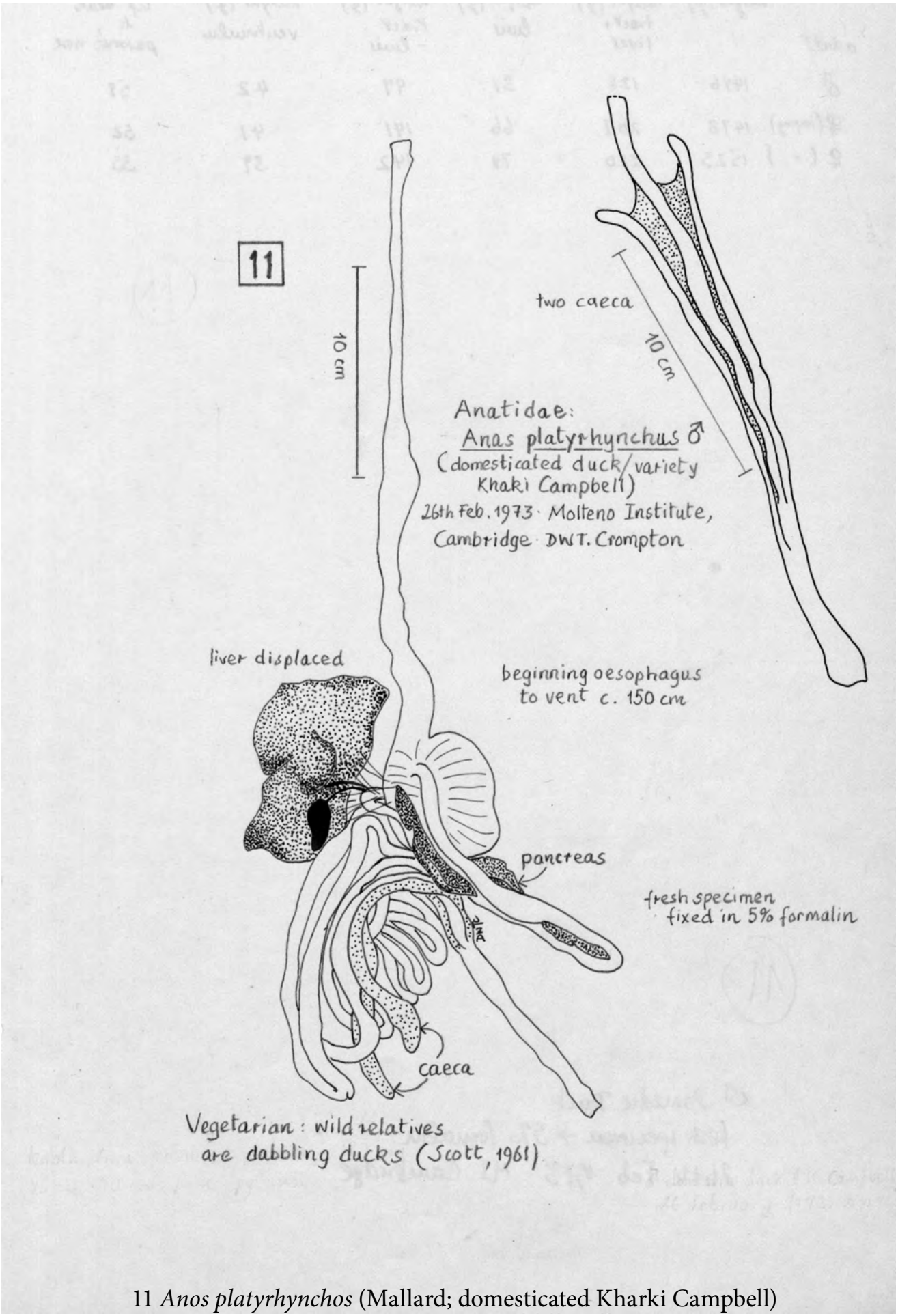
8 *Branta canadensis* (Canada Goose)



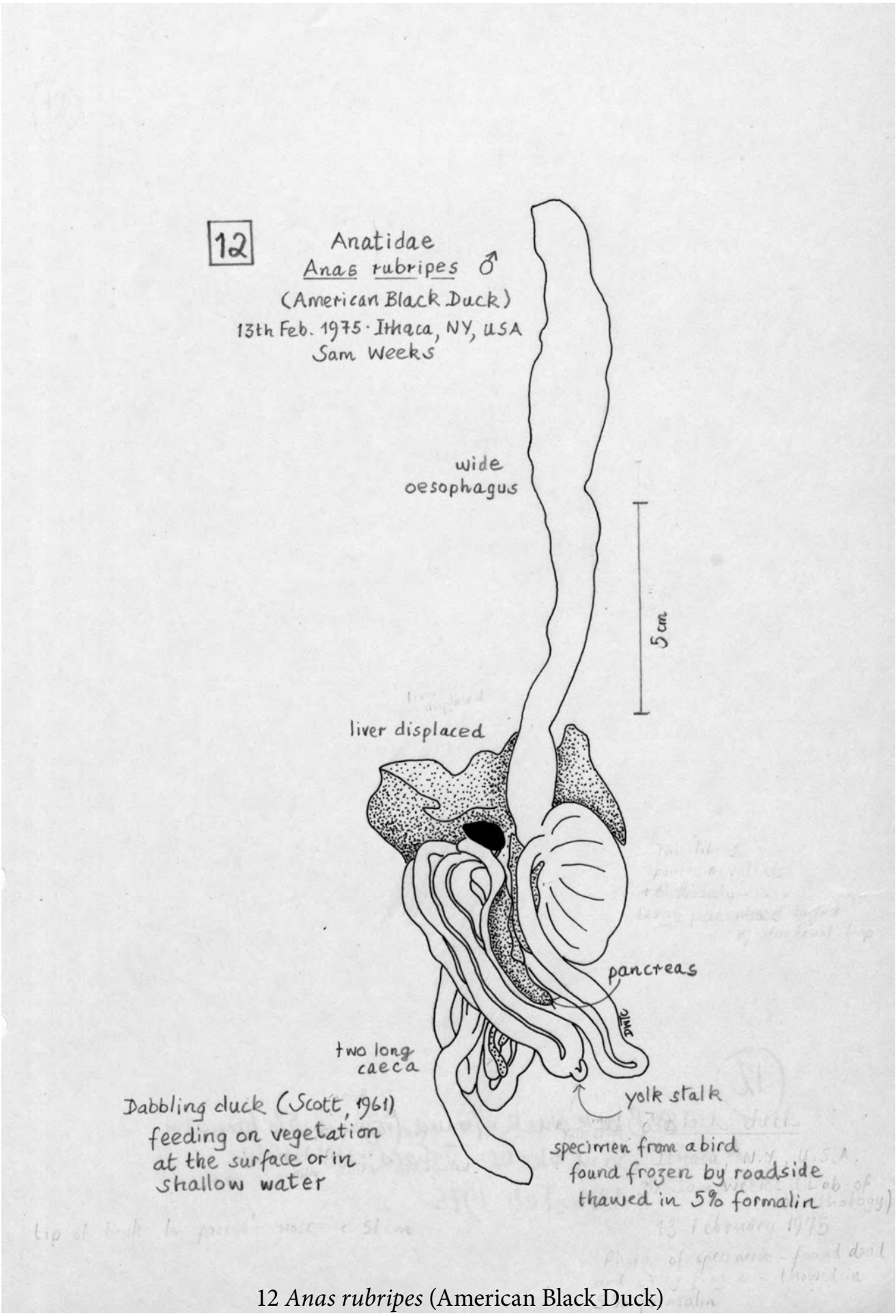
9 *Anser brachyrhynchus* (Pink-footed Goose)



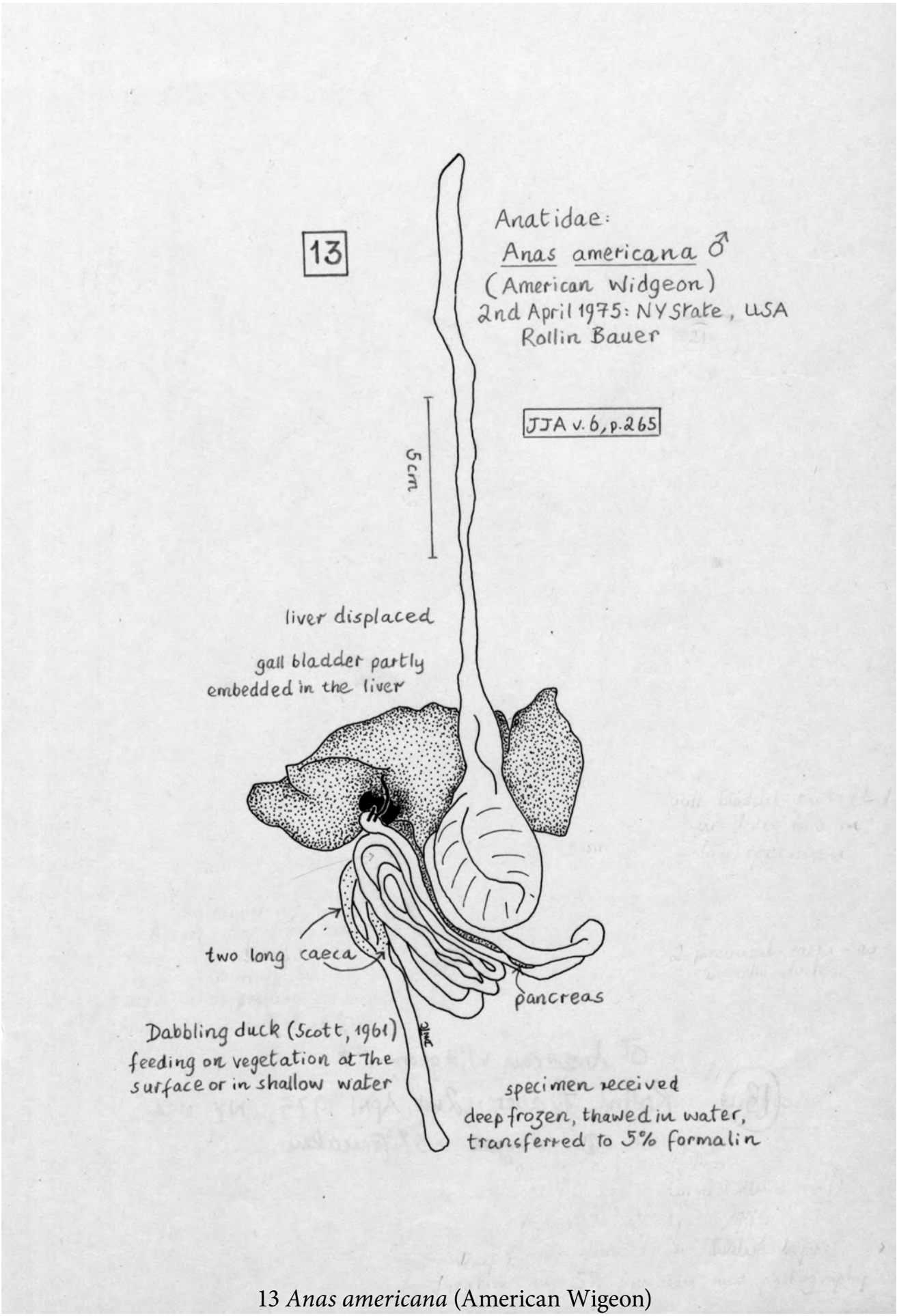
10 *Anser anser domesticus* (Domesticated Goose)



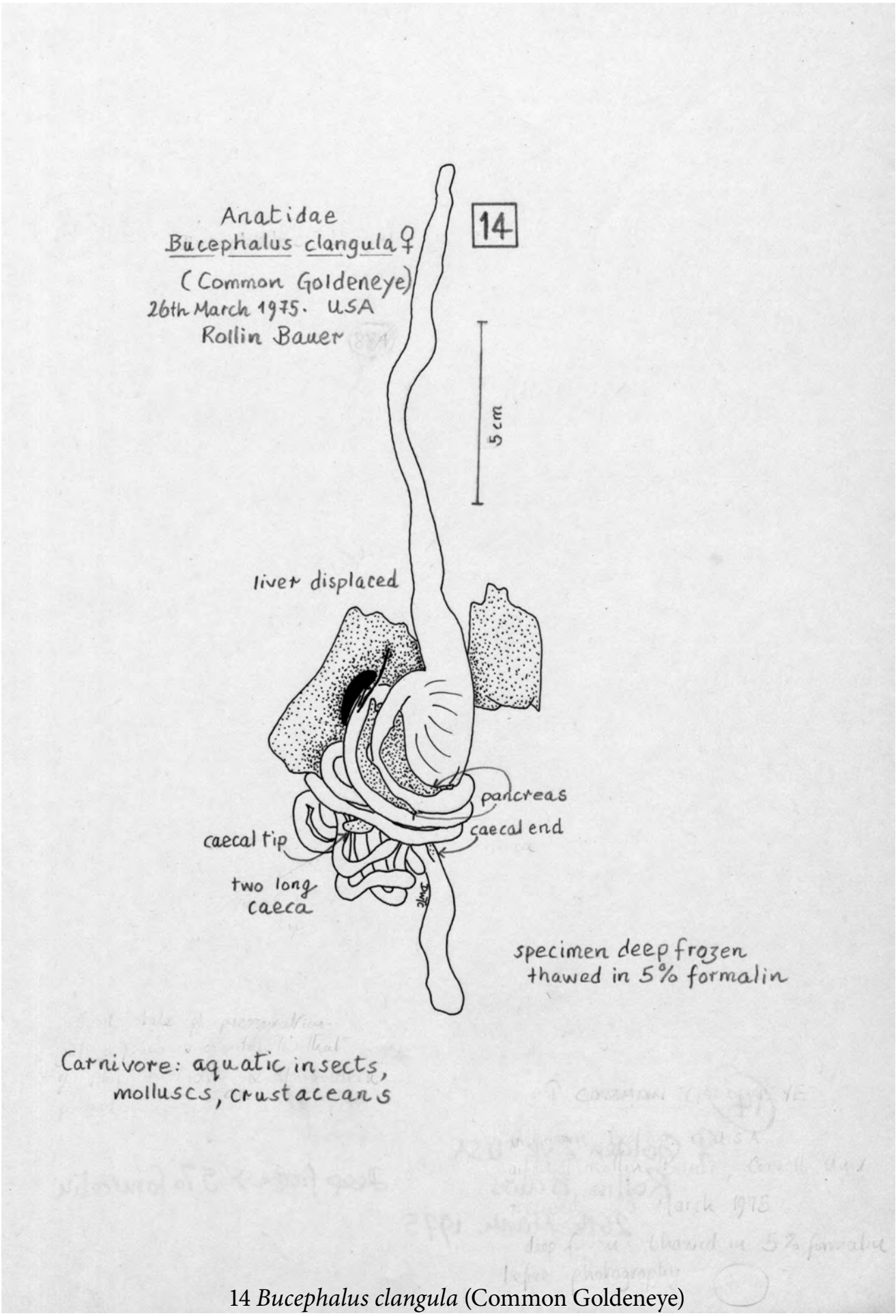
11 *Anos platyrhynchos* (Mallard; domesticated Kharki Campbell)



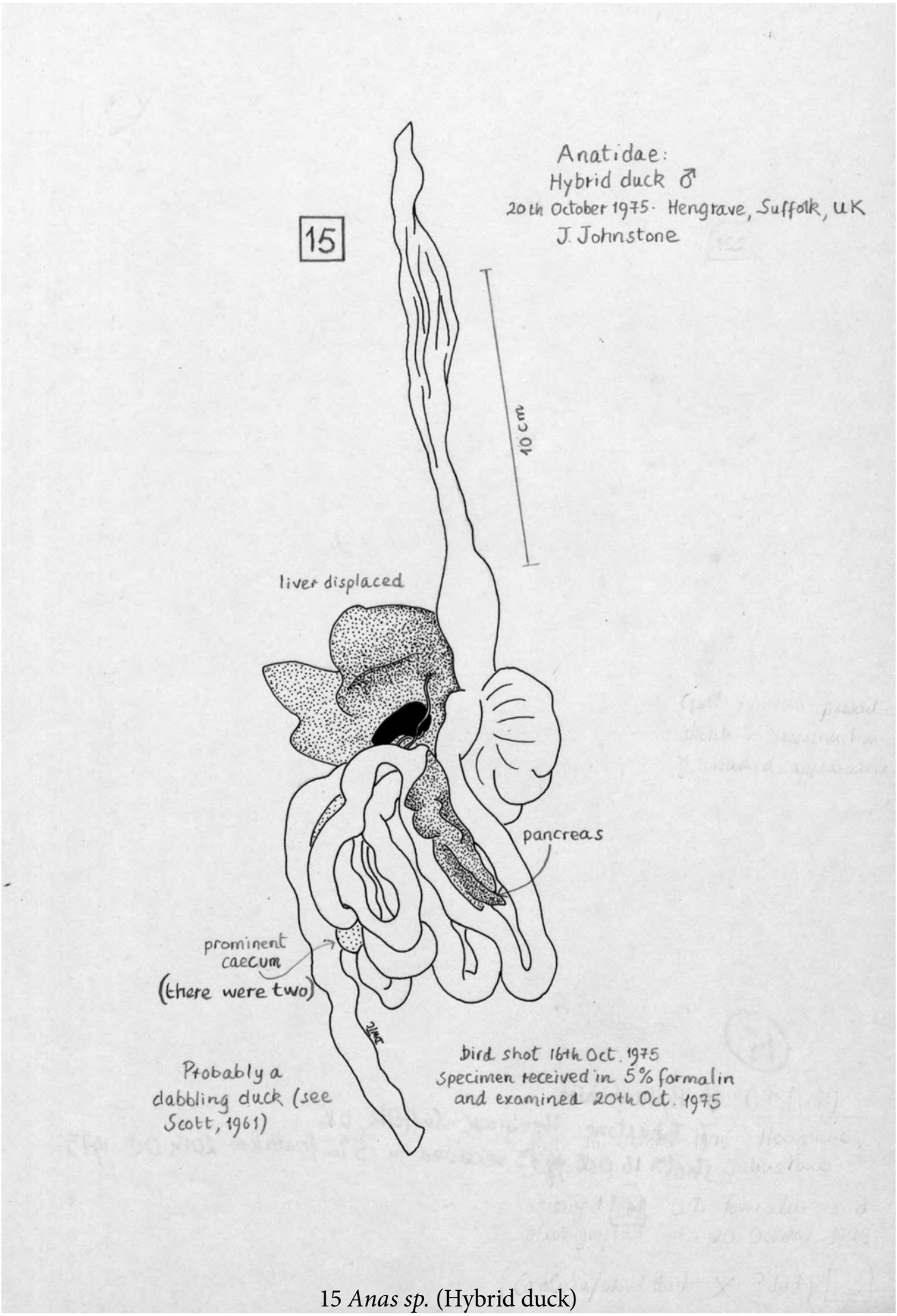
12 *Anas rubripes* (American Black Duck)



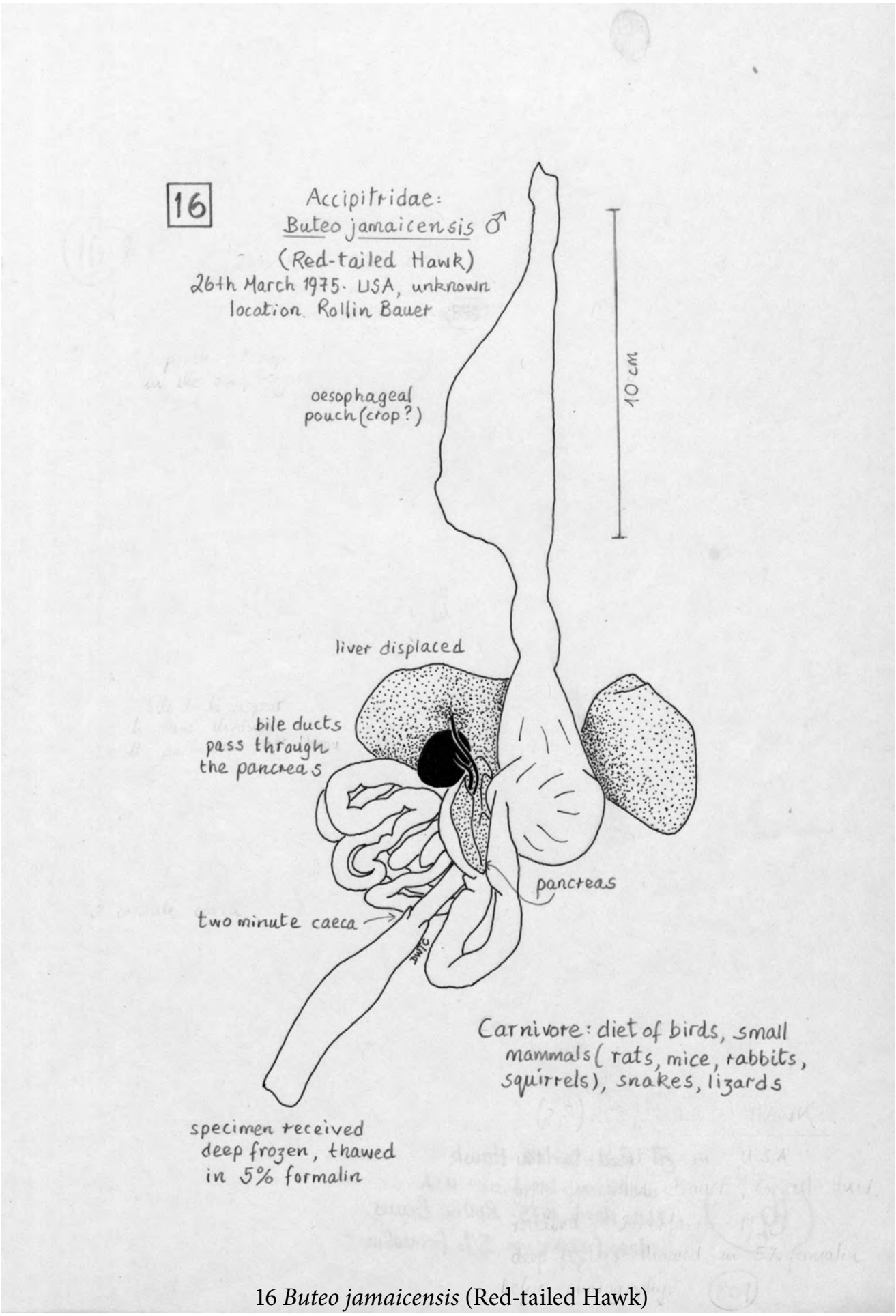
13 *Anas americana* (American Wigeon)



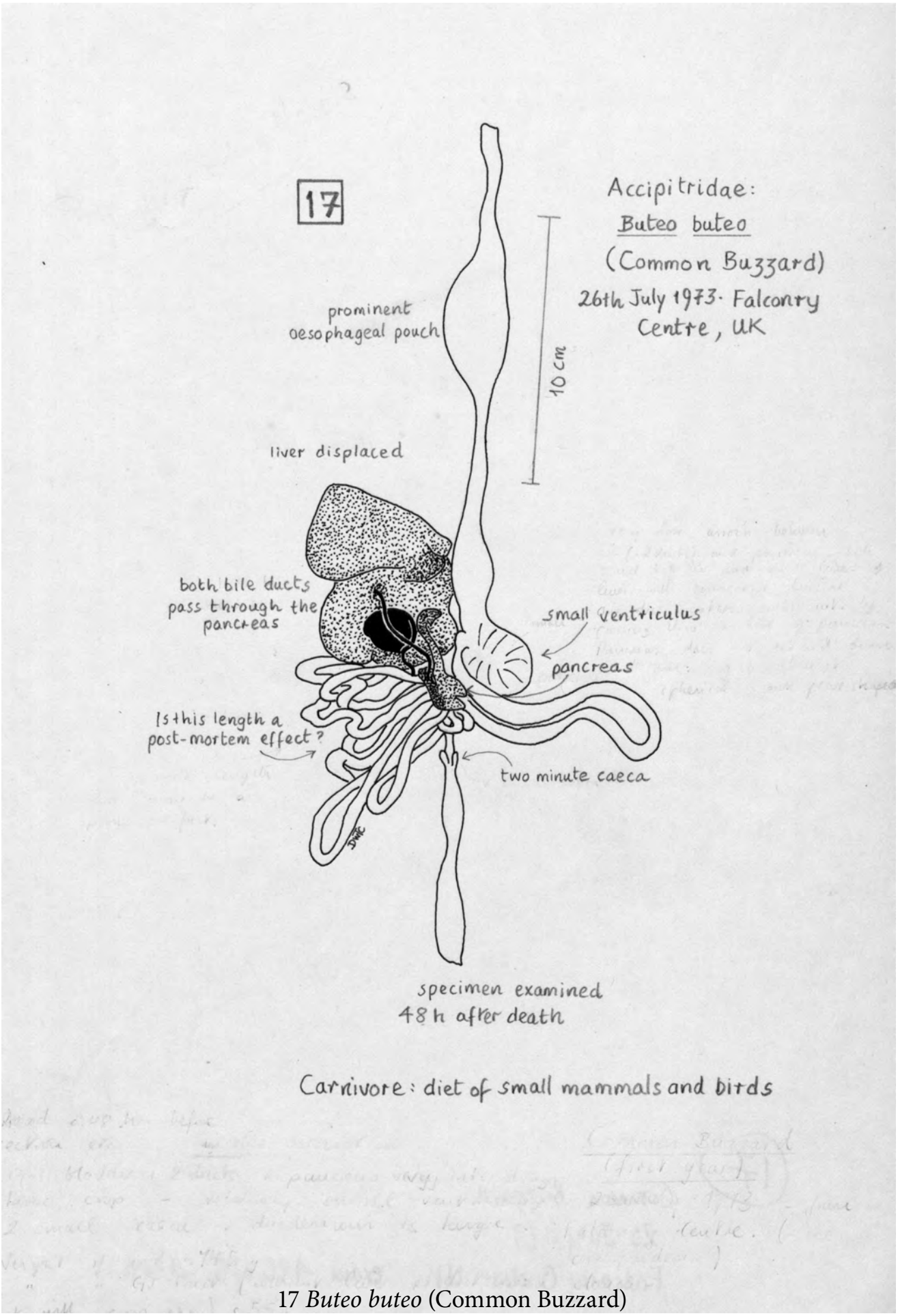
14 *Bucephalus clangula* (Common Goldeneye)



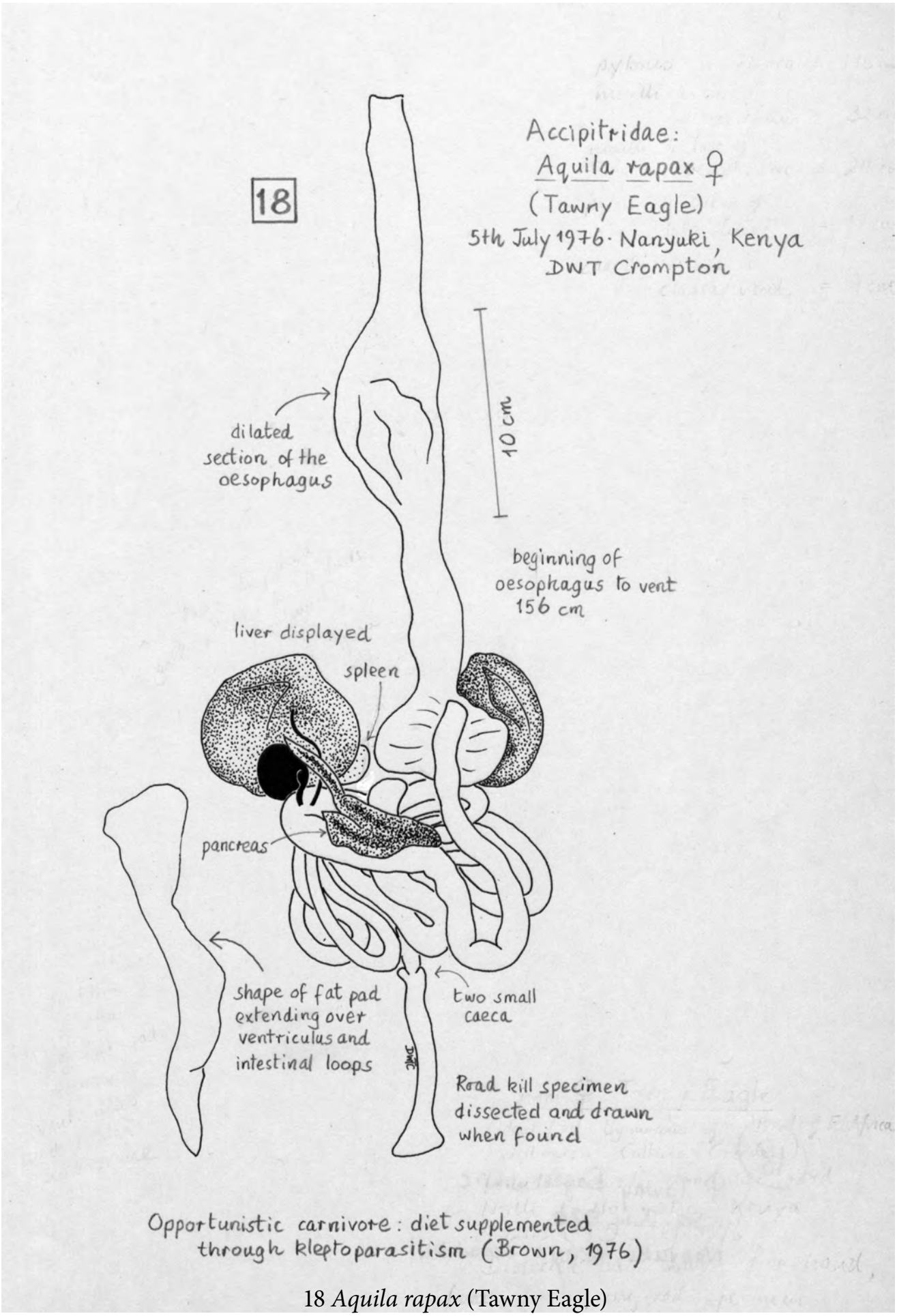
15 *Anas sp.* (Hybrid duck)



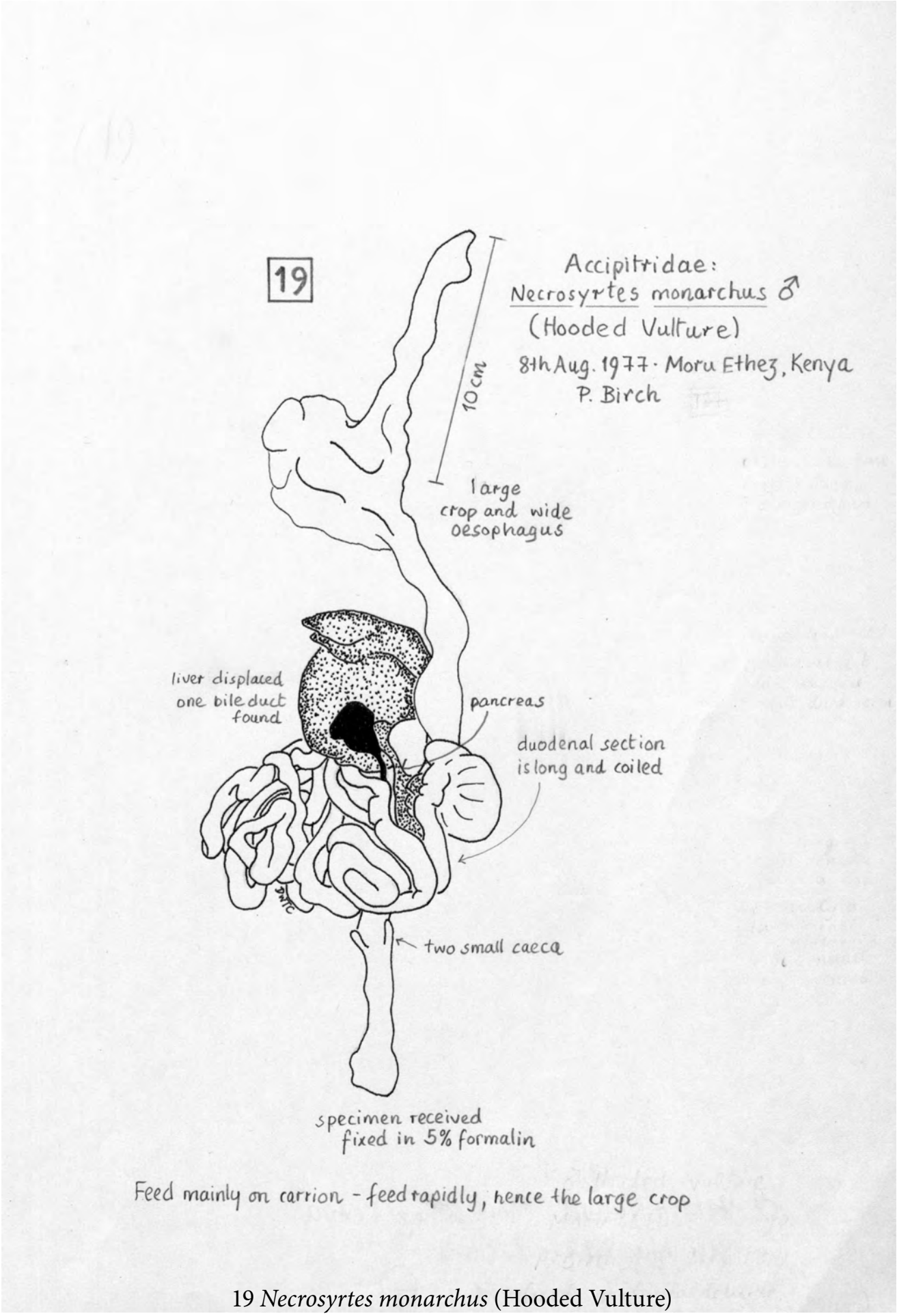
16 *Buteo jamaicensis* (Red-tailed Hawk)



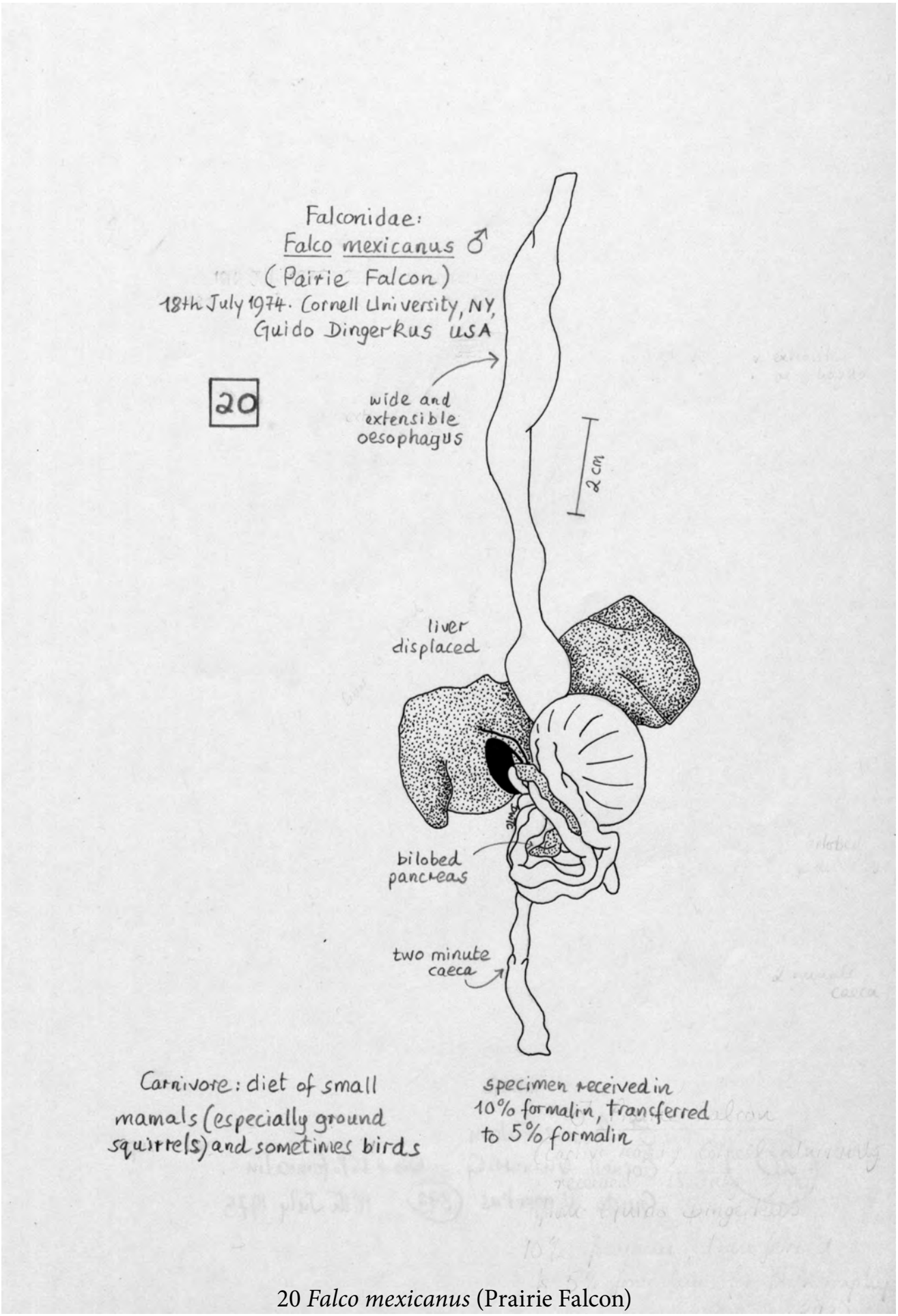
17 *Buteo buteo* (Common Buzzard)



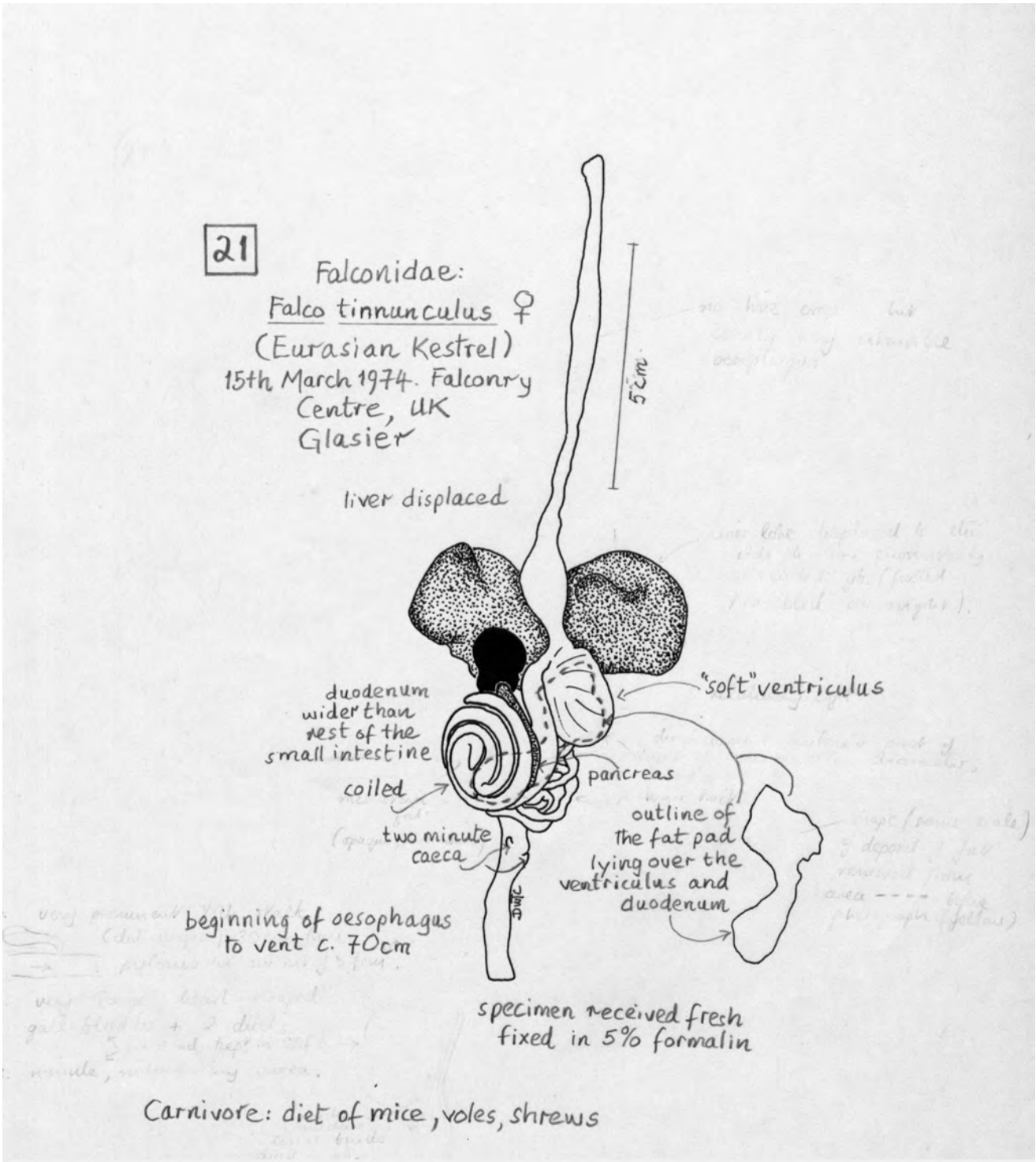
18 *Aquila rapax* (Tawny Eagle)



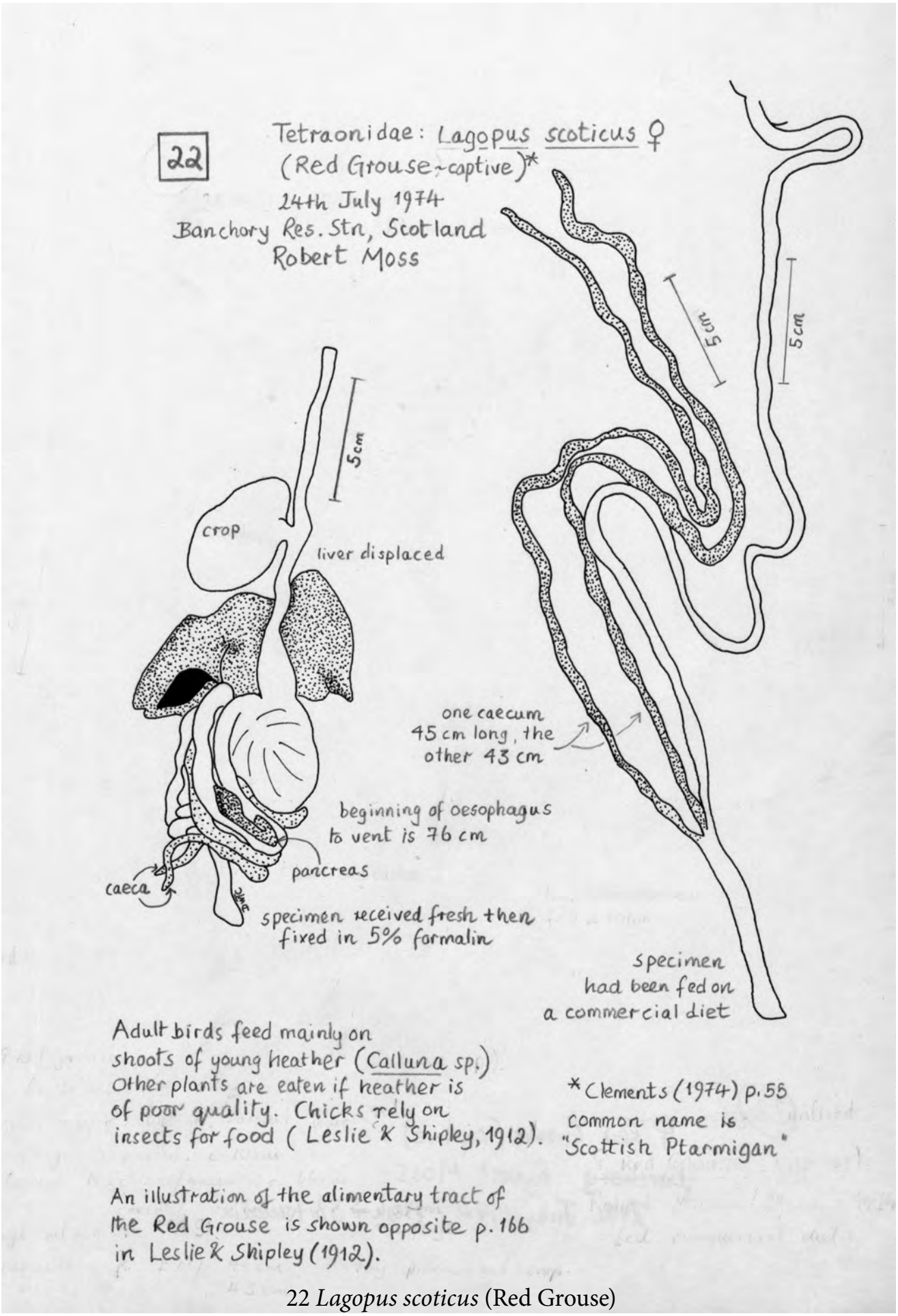
19 *Necrosyrtes monarchus* (Hooded Vulture)



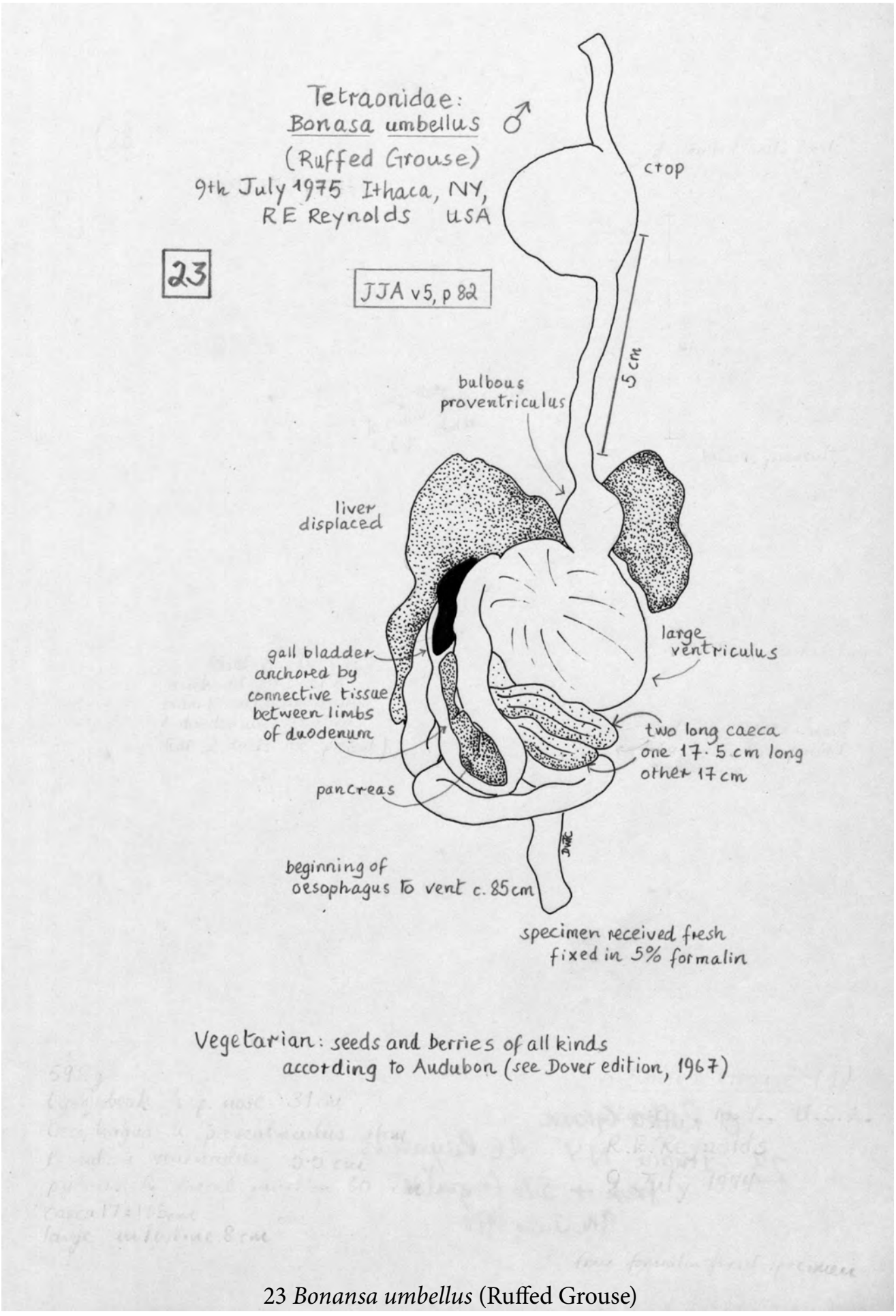
20 *Falco mexicanus* (Prairie Falcon)



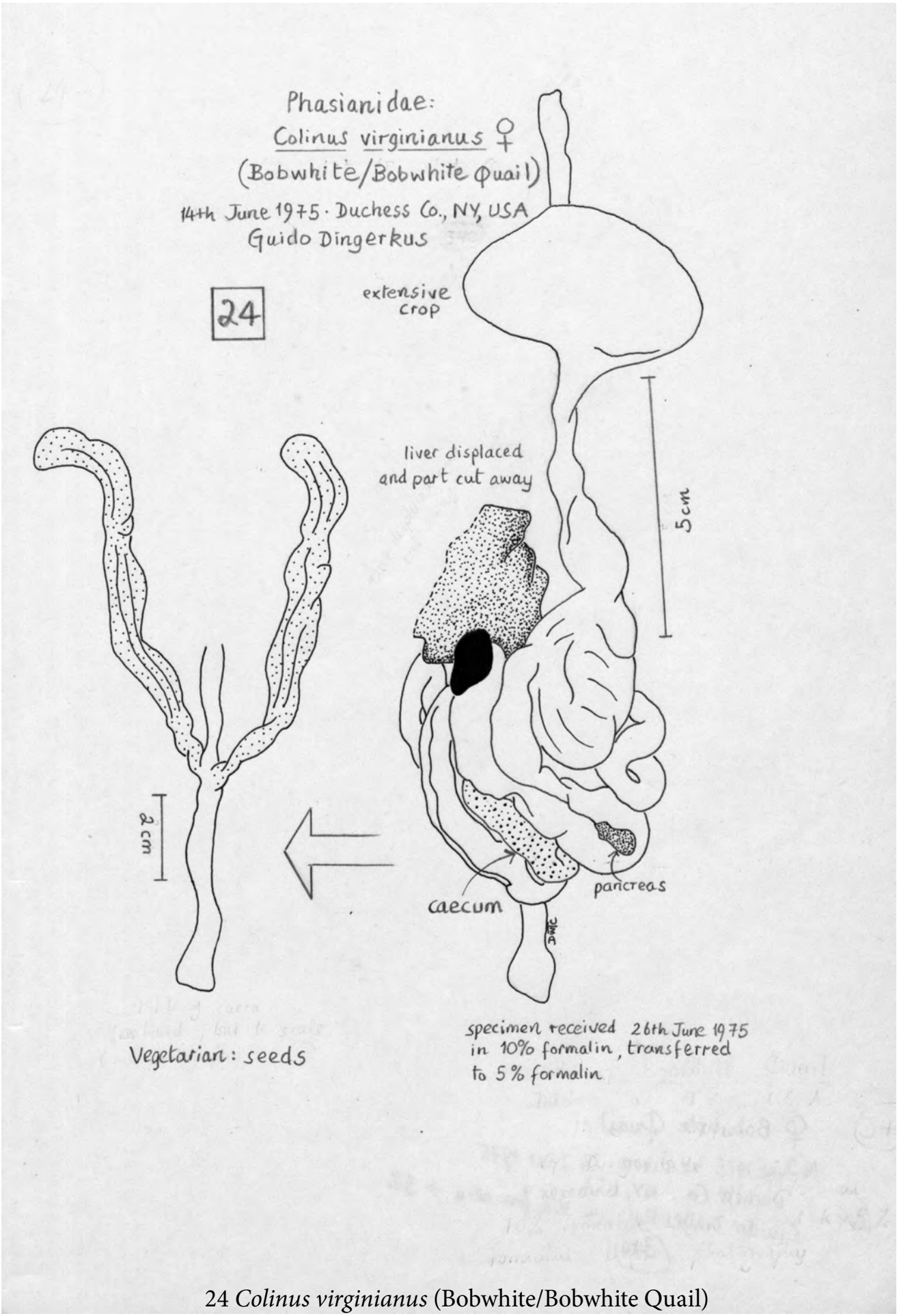
21 *Falco tinnunculus* (Eurasian Kestrel)



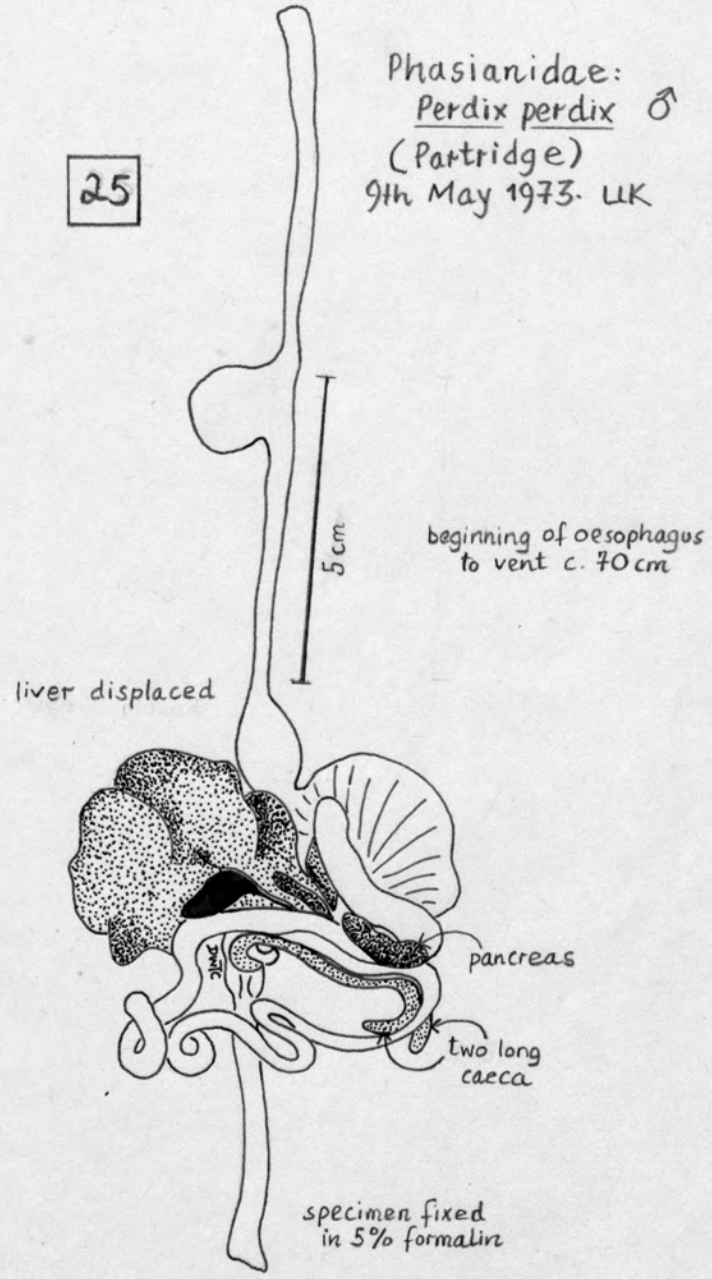
22 *Lagopus scoticus* (Red Grouse)



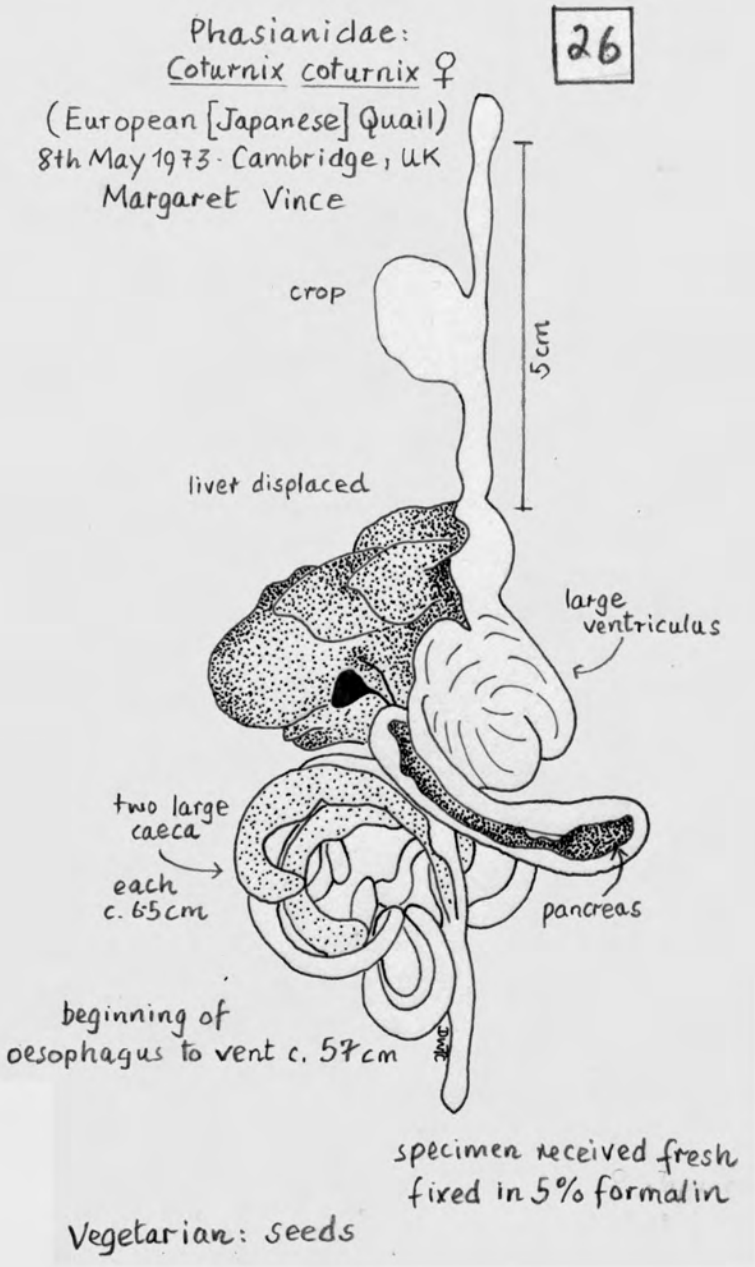
23 *Bonansa umbellus* (Ruffed Grouse)



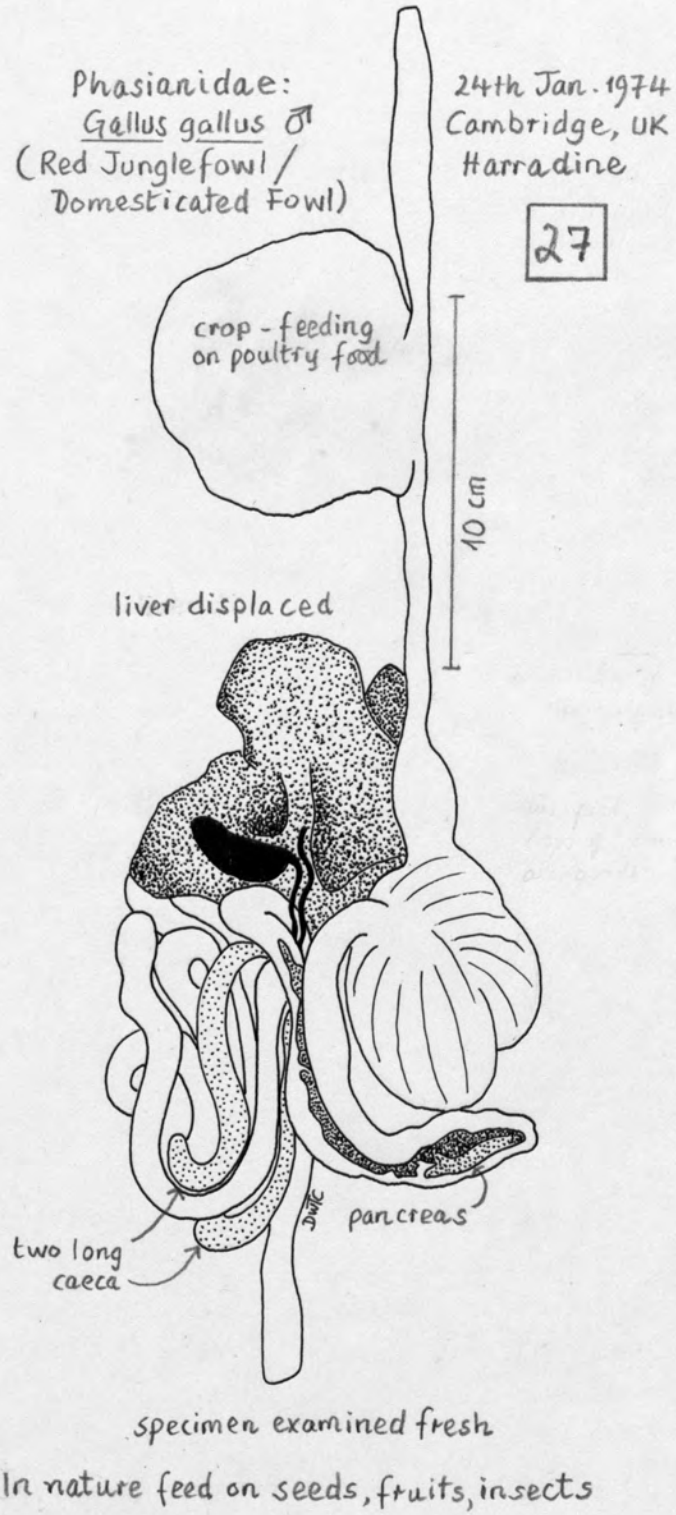
24 *Colinus virginianus* (Bobwhite/Bobwhite Quail)



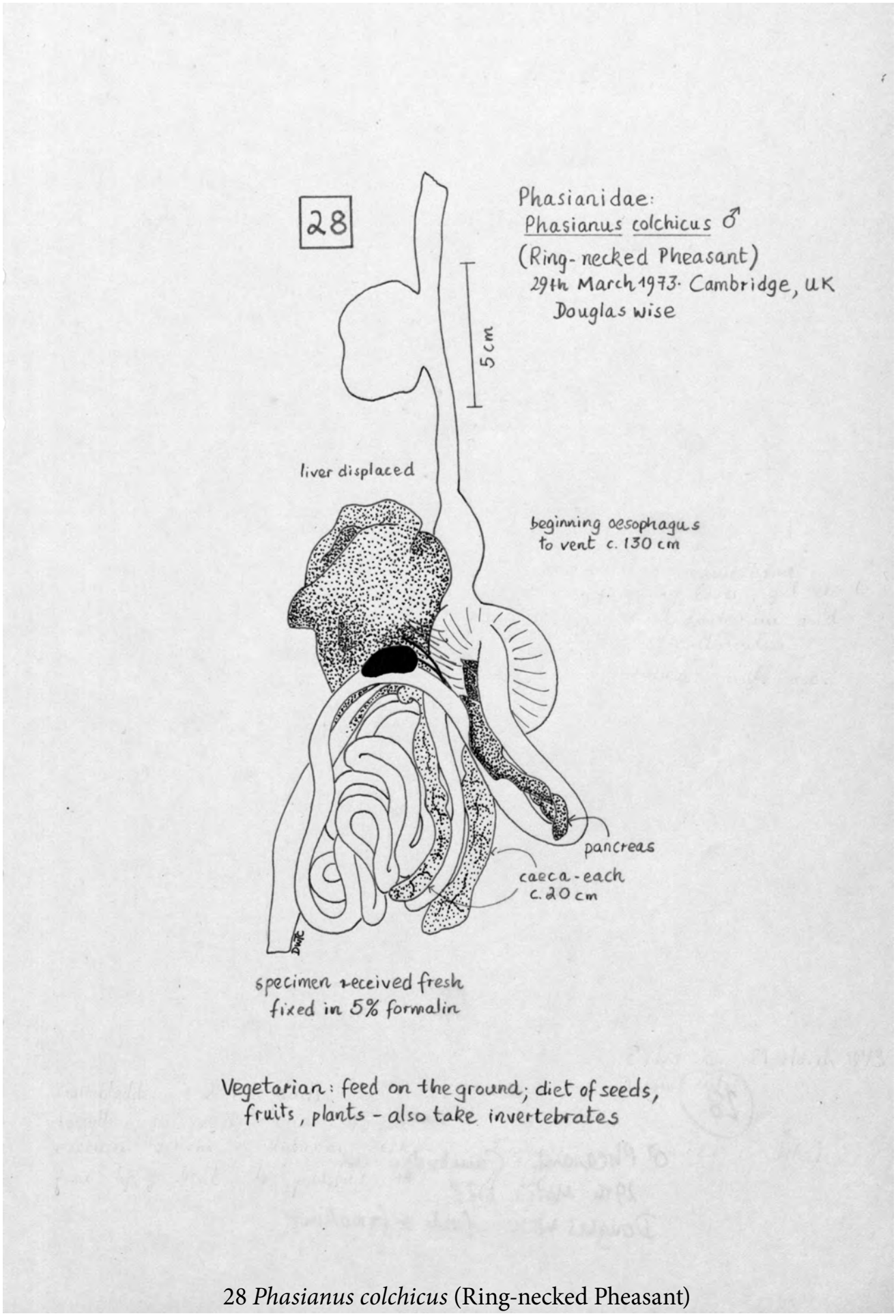
25 *Perdix perdix* (Partridge)



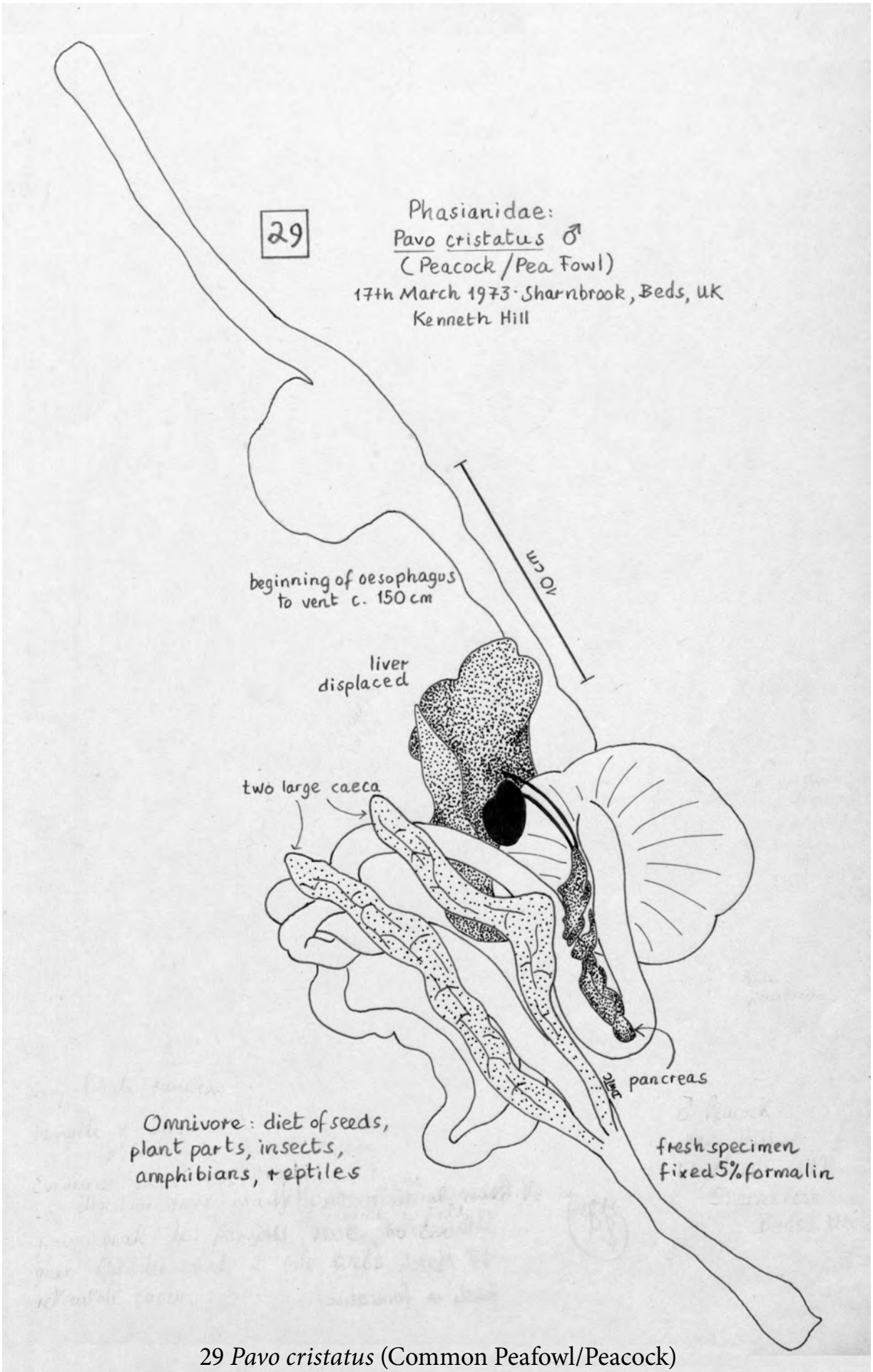
26 *Coturnix coturnix* (European [Japanese] Quail)



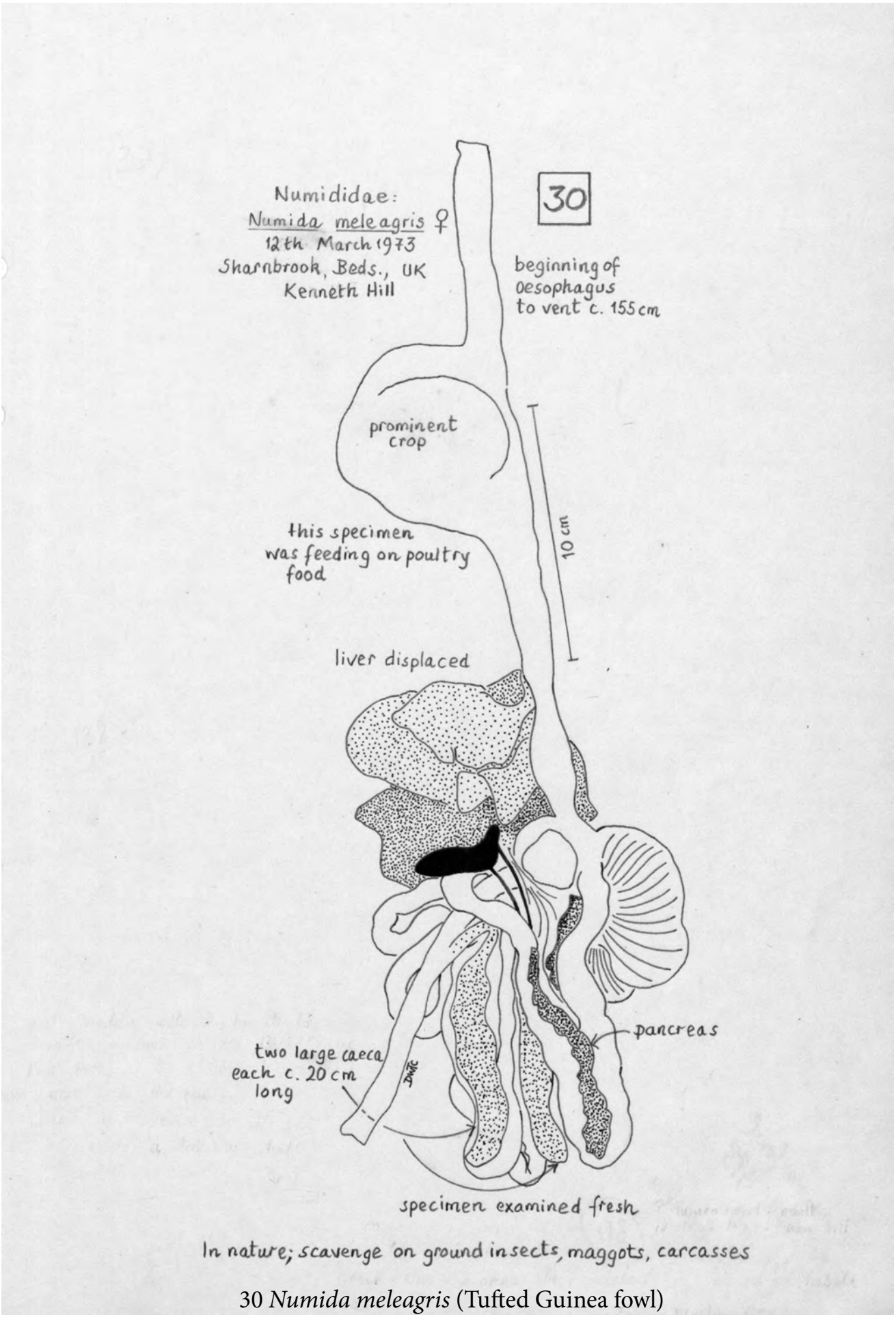
27 *Gallus gallus* (Red Jungle Fowl/Domesticated Fowl)



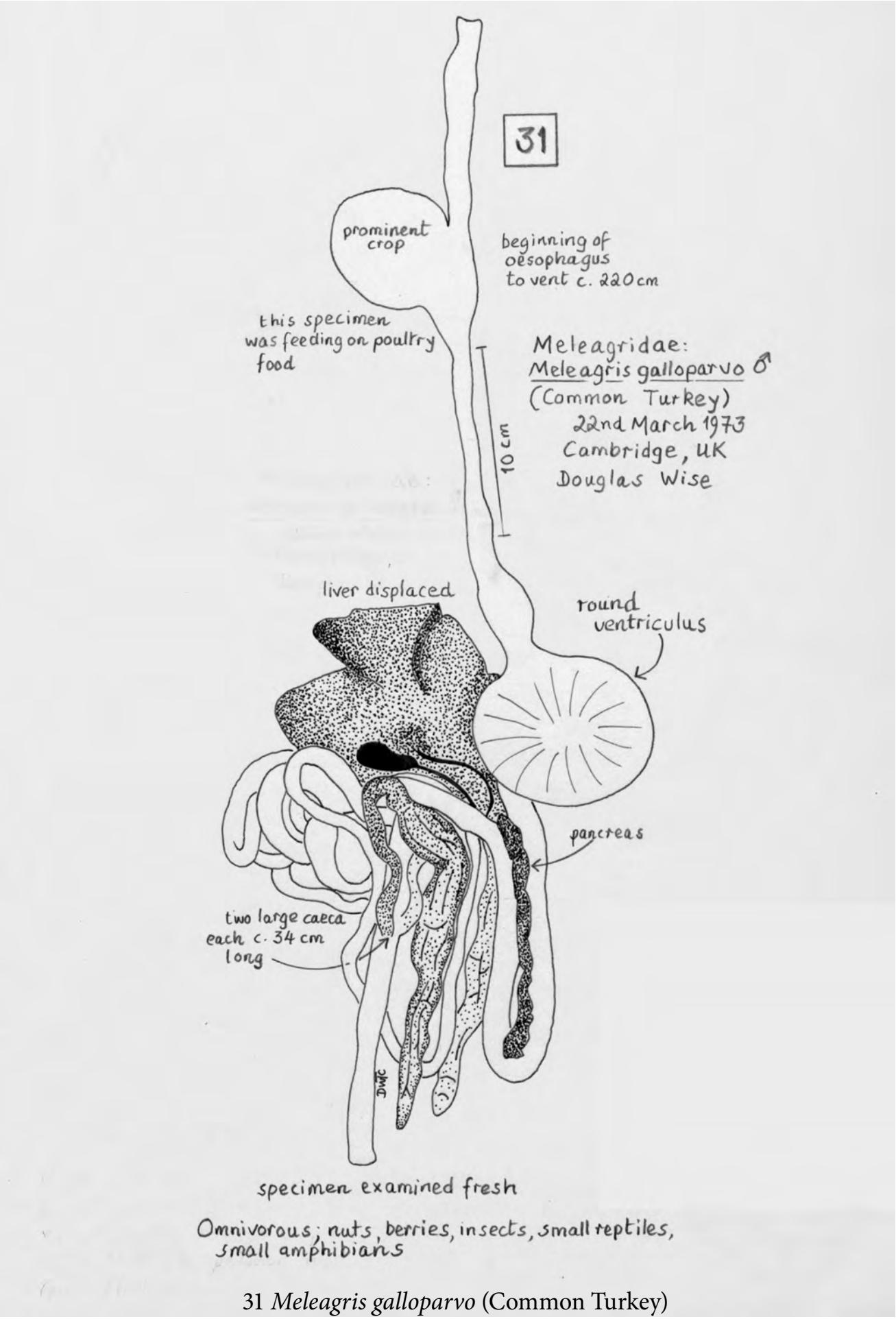
28 *Phasianus colchicus* (Ring-necked Pheasant)



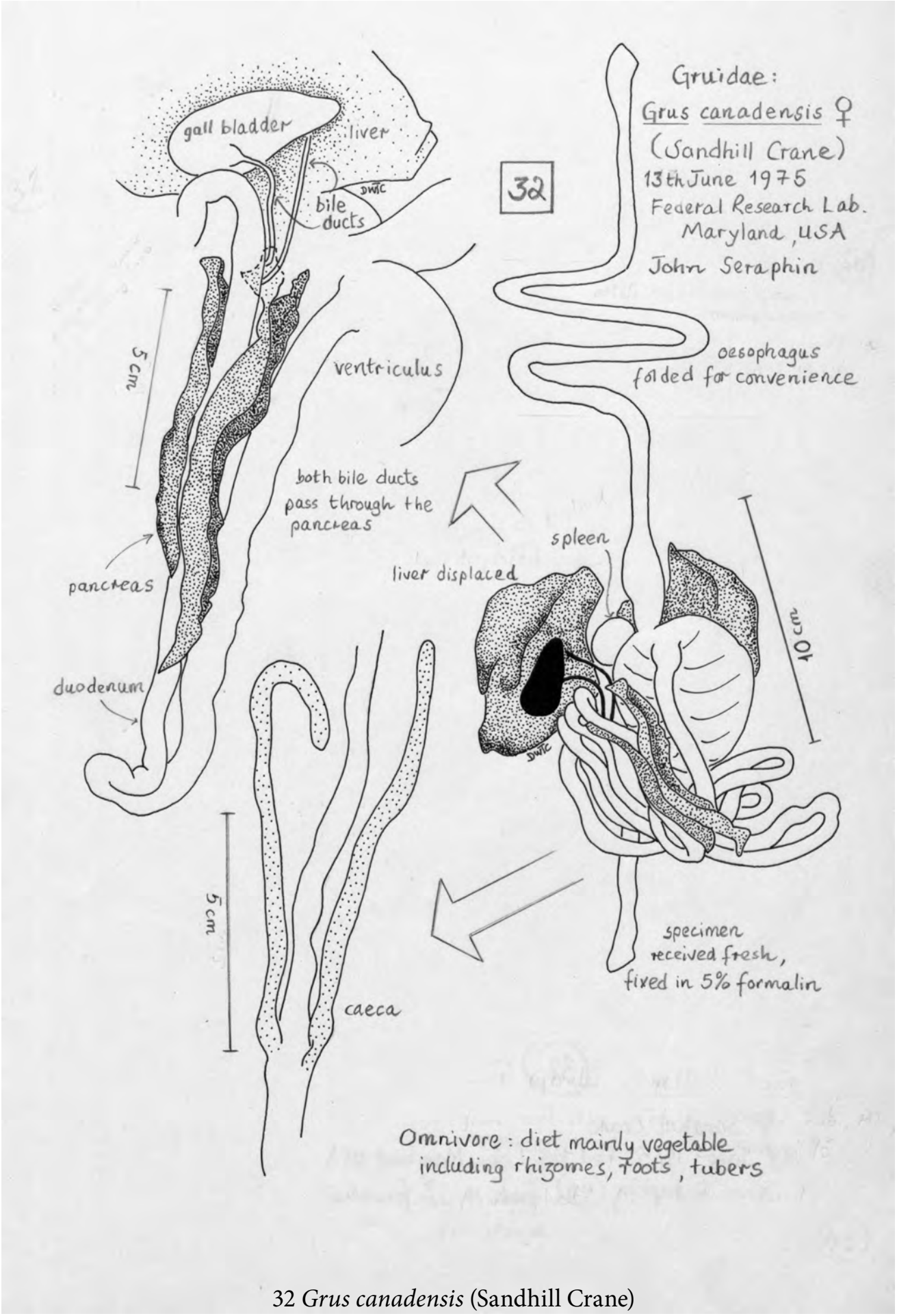
29 *Pavo cristatus* (Common Peafowl/Peacock)



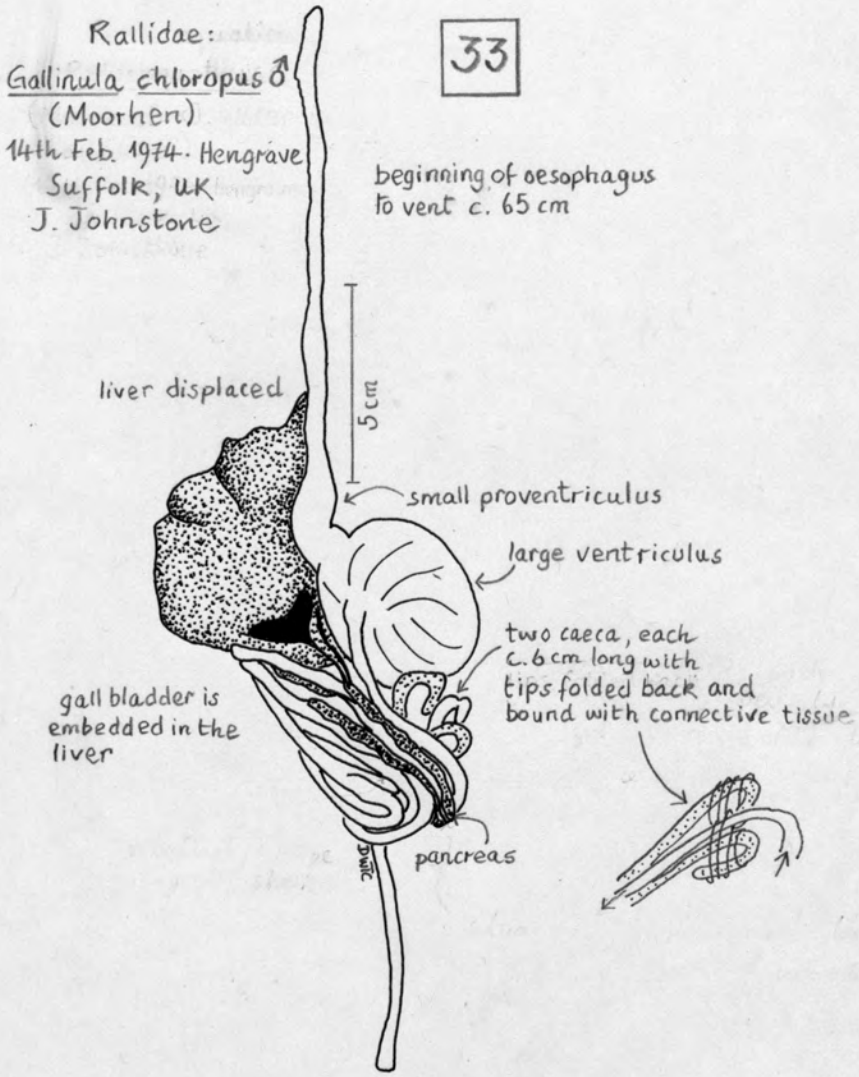
30 *Numida meleagris* (Tufted Guinea fowl)



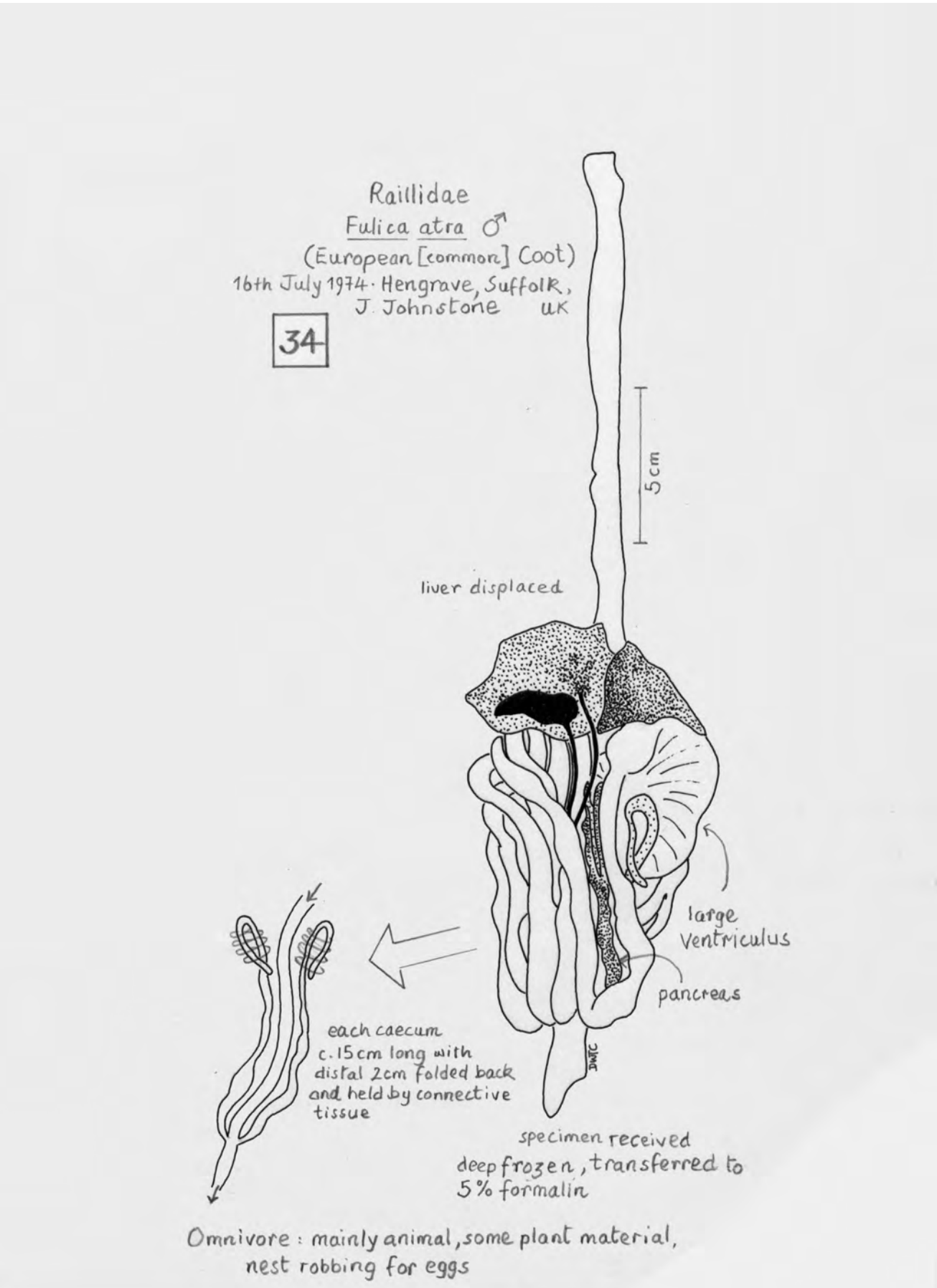
31 *Meleagris galloparvo* (Common Turkey)



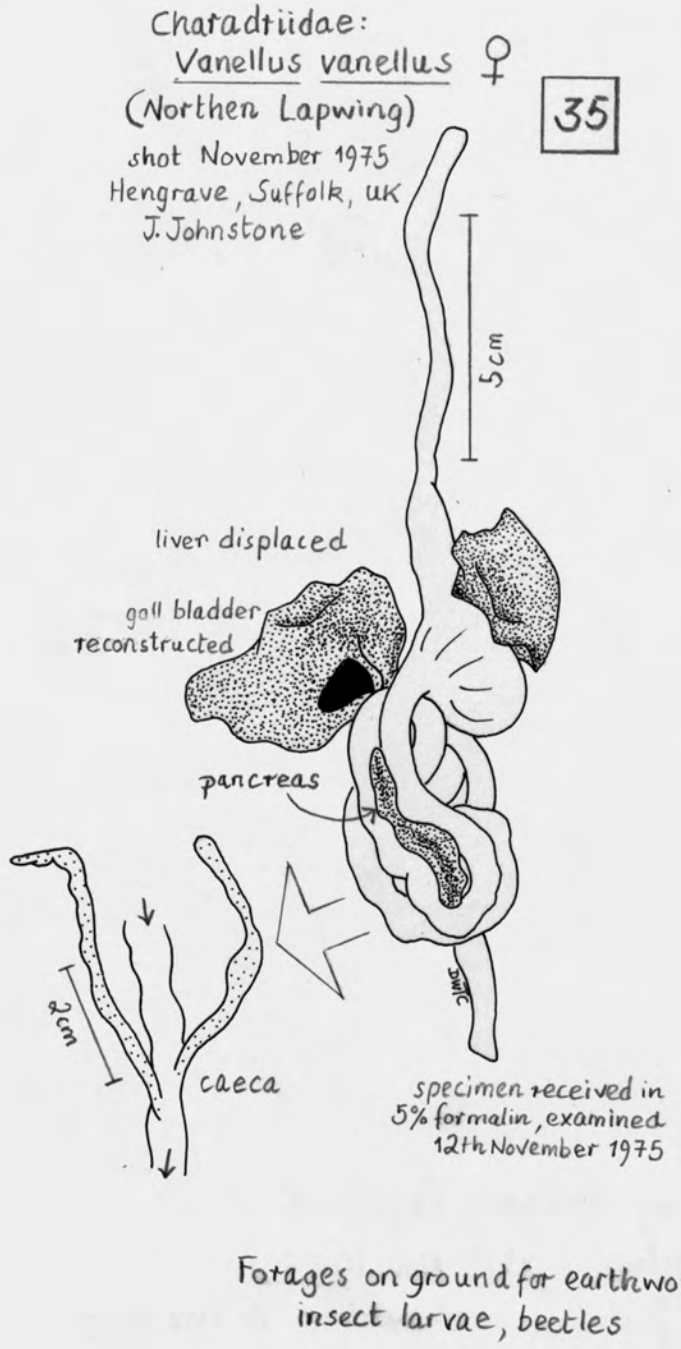
32 *Grus canadensis* (Sandhill Crane)



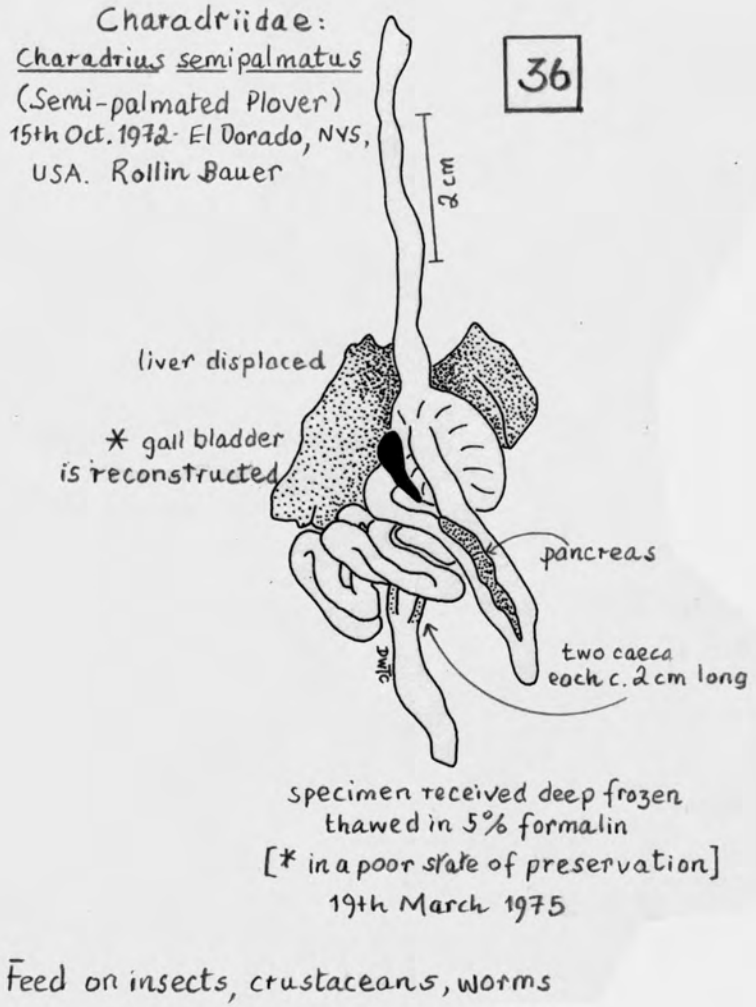
33 *Gallinula chloropus* (Moorhen)



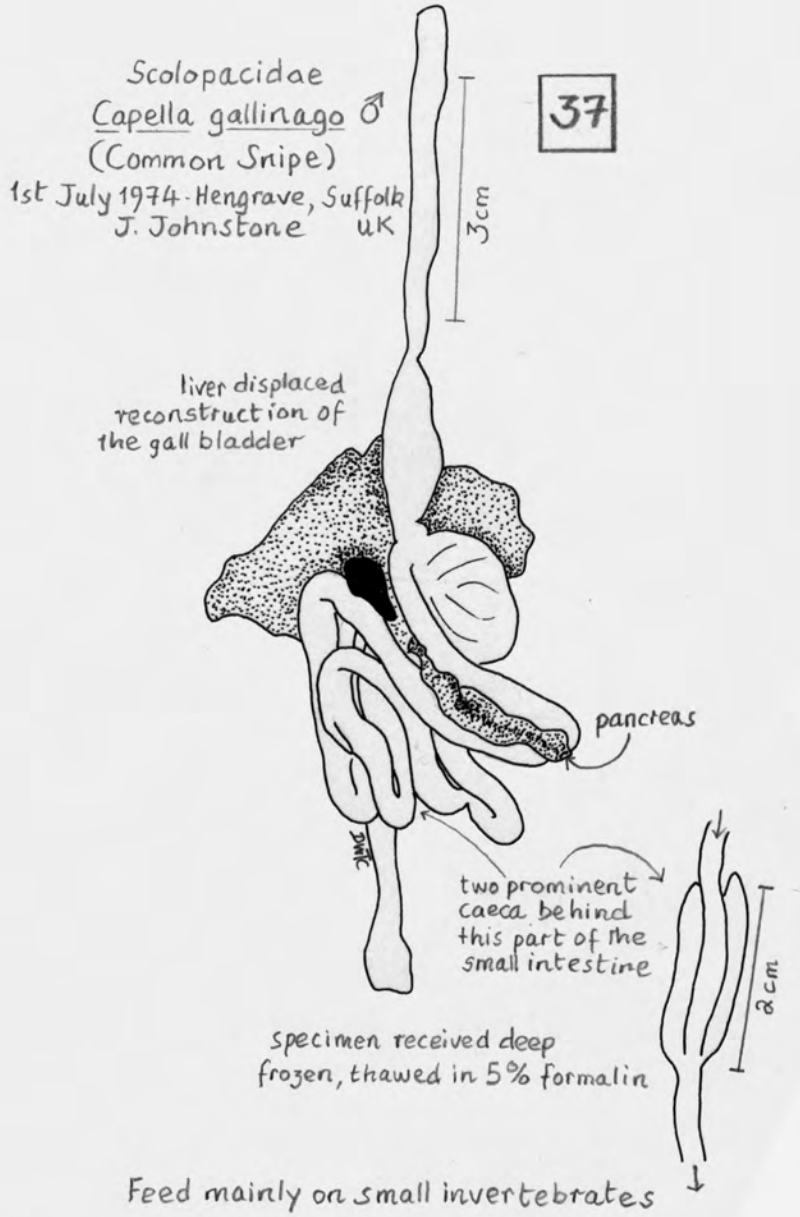
34 *Fulica atra* (Coot)



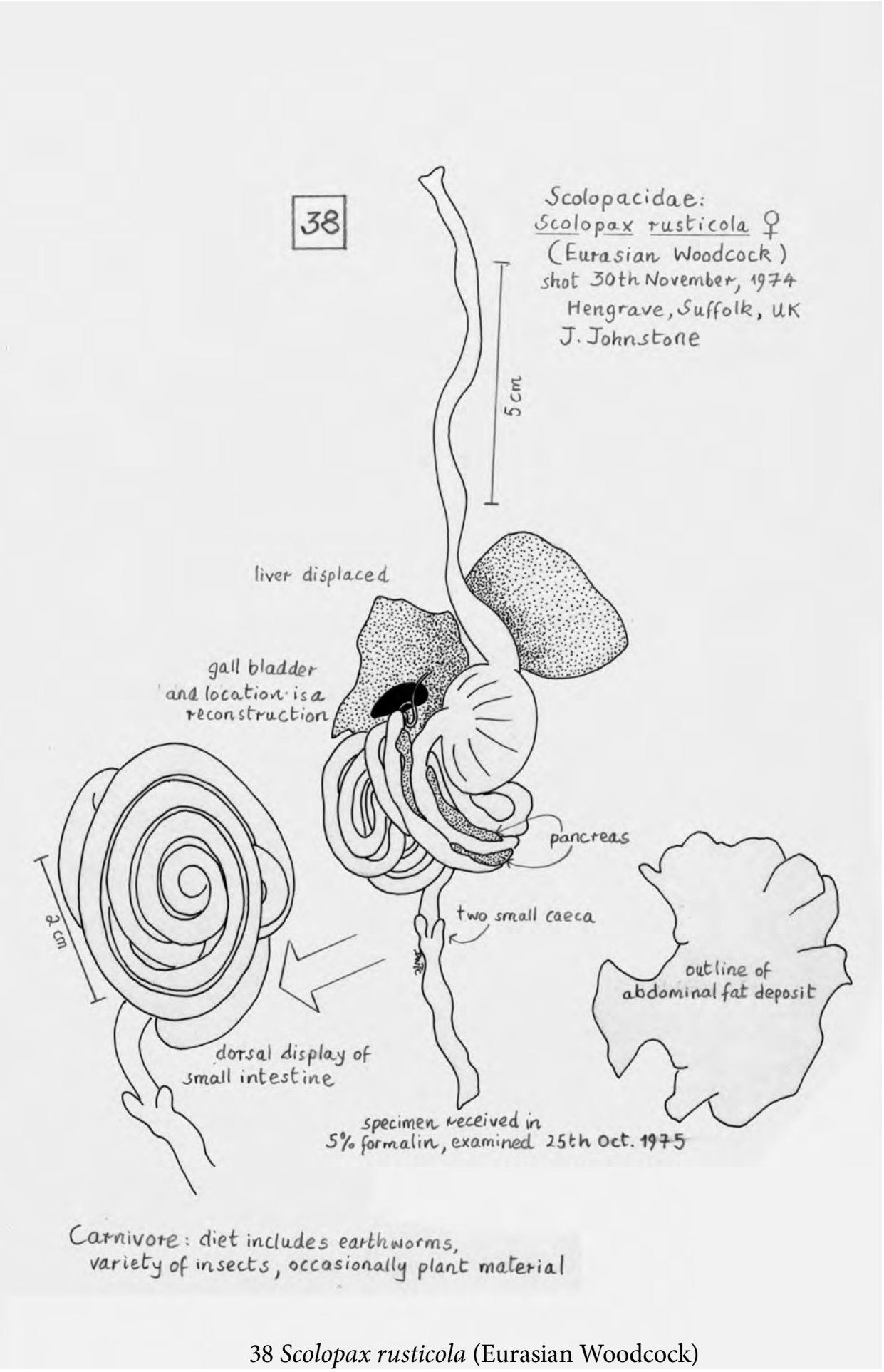
35 *Vanellus vanellus* (Northern Lapwing)



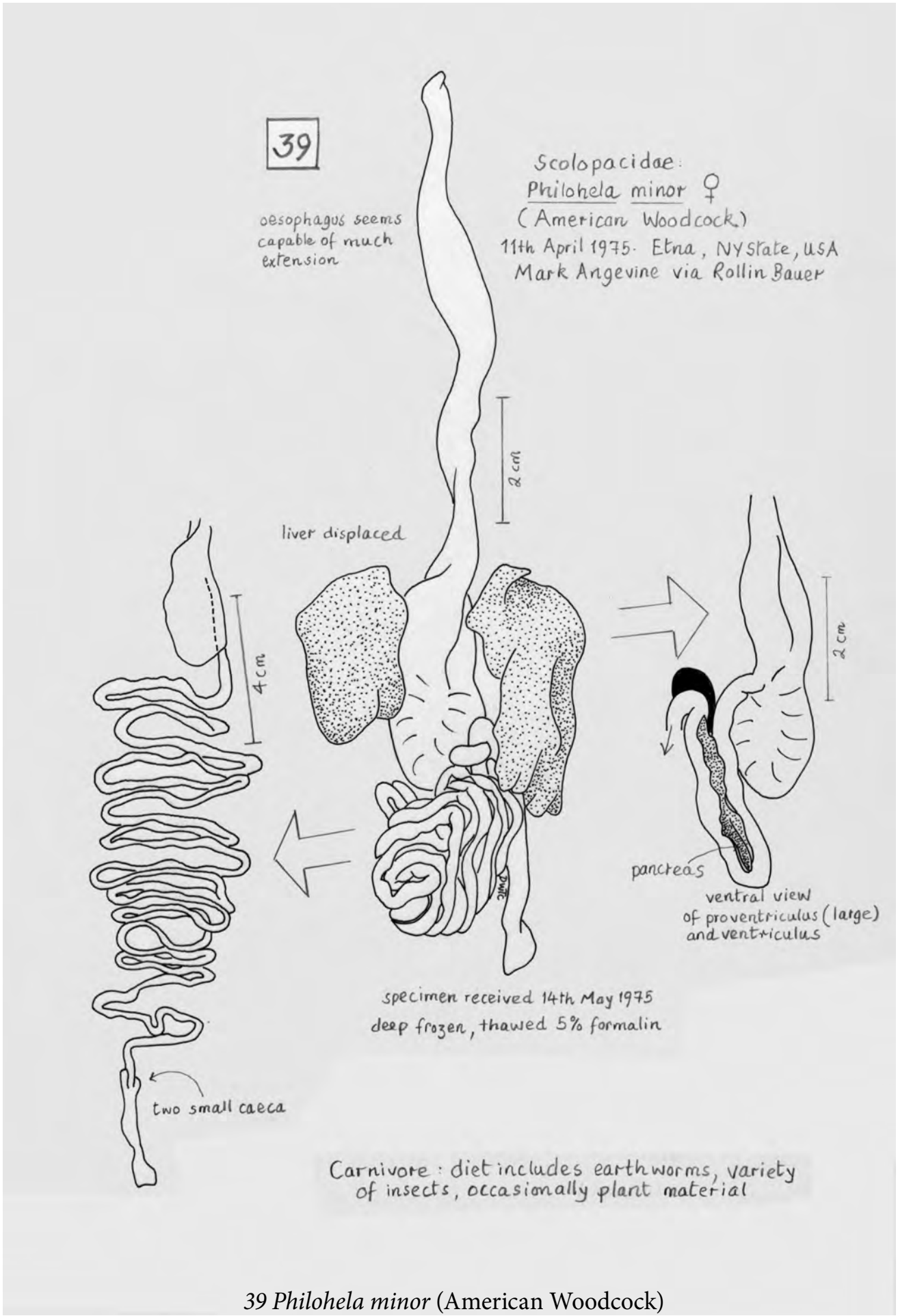
36 *Charadrius semipalmatus* (Semi-palmated Plover)



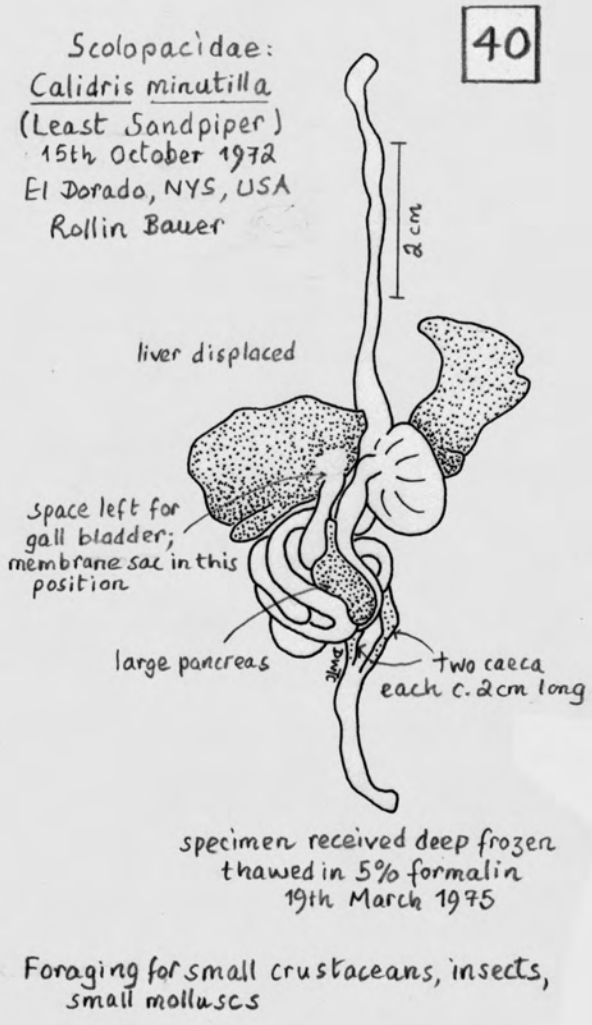
37 Capella gallinago (Common Snipe)



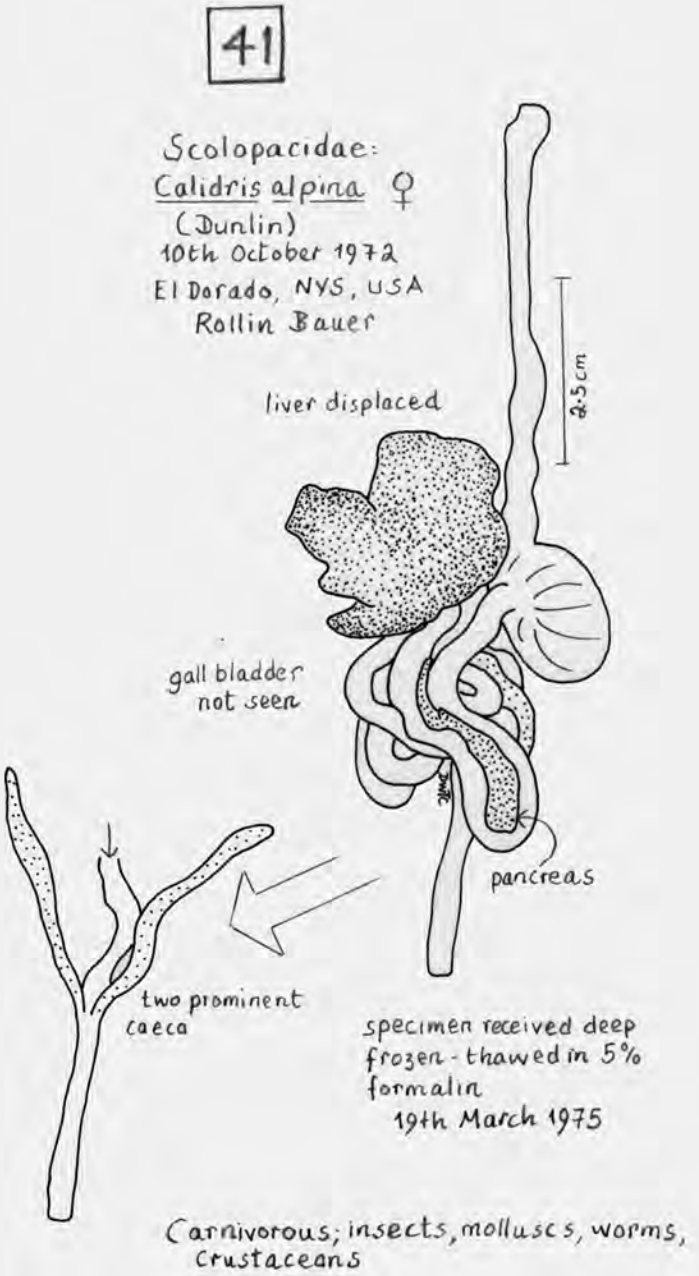
38 *Scolopax rusticola* (Eurasian Woodcock)



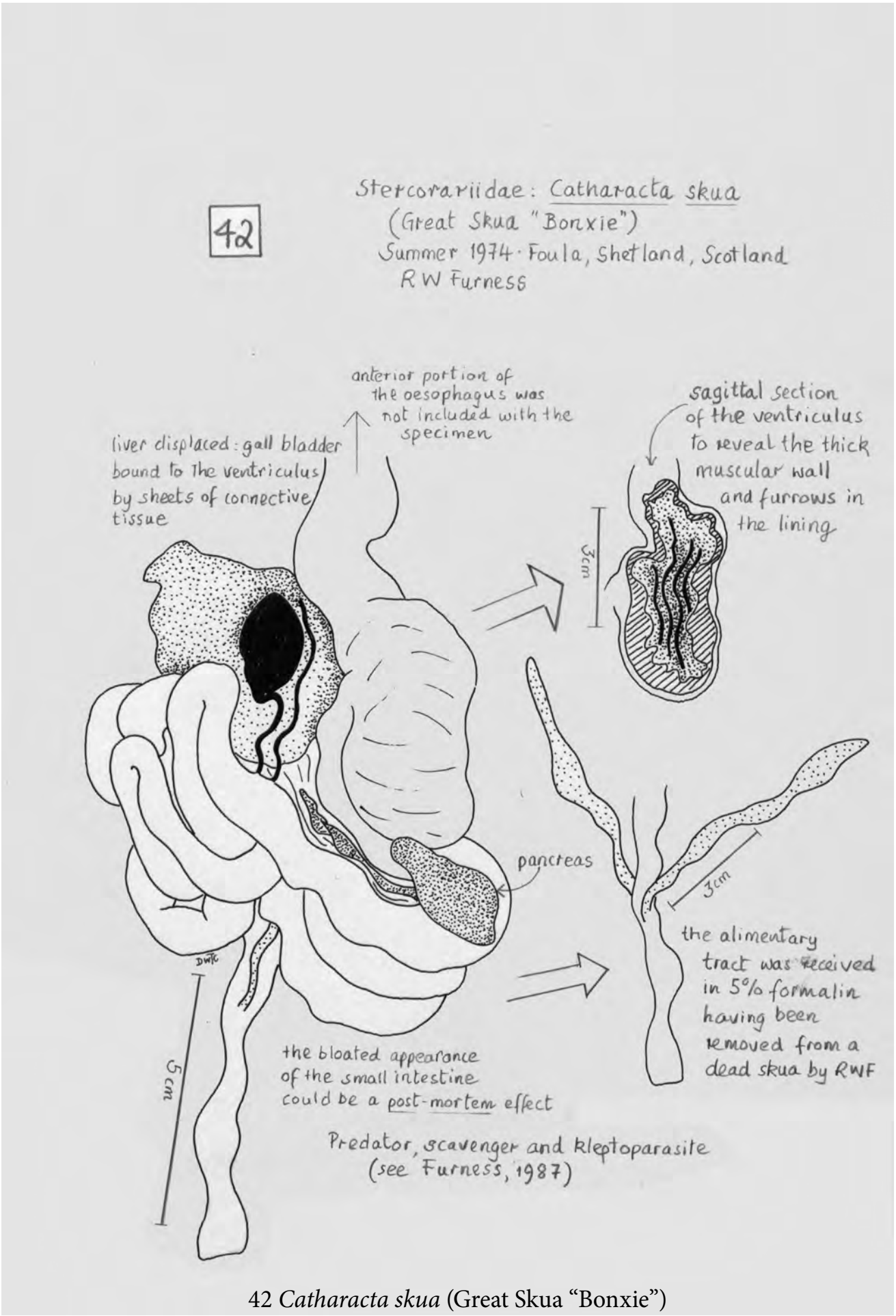
39 Philohela minor (American Woodcock)



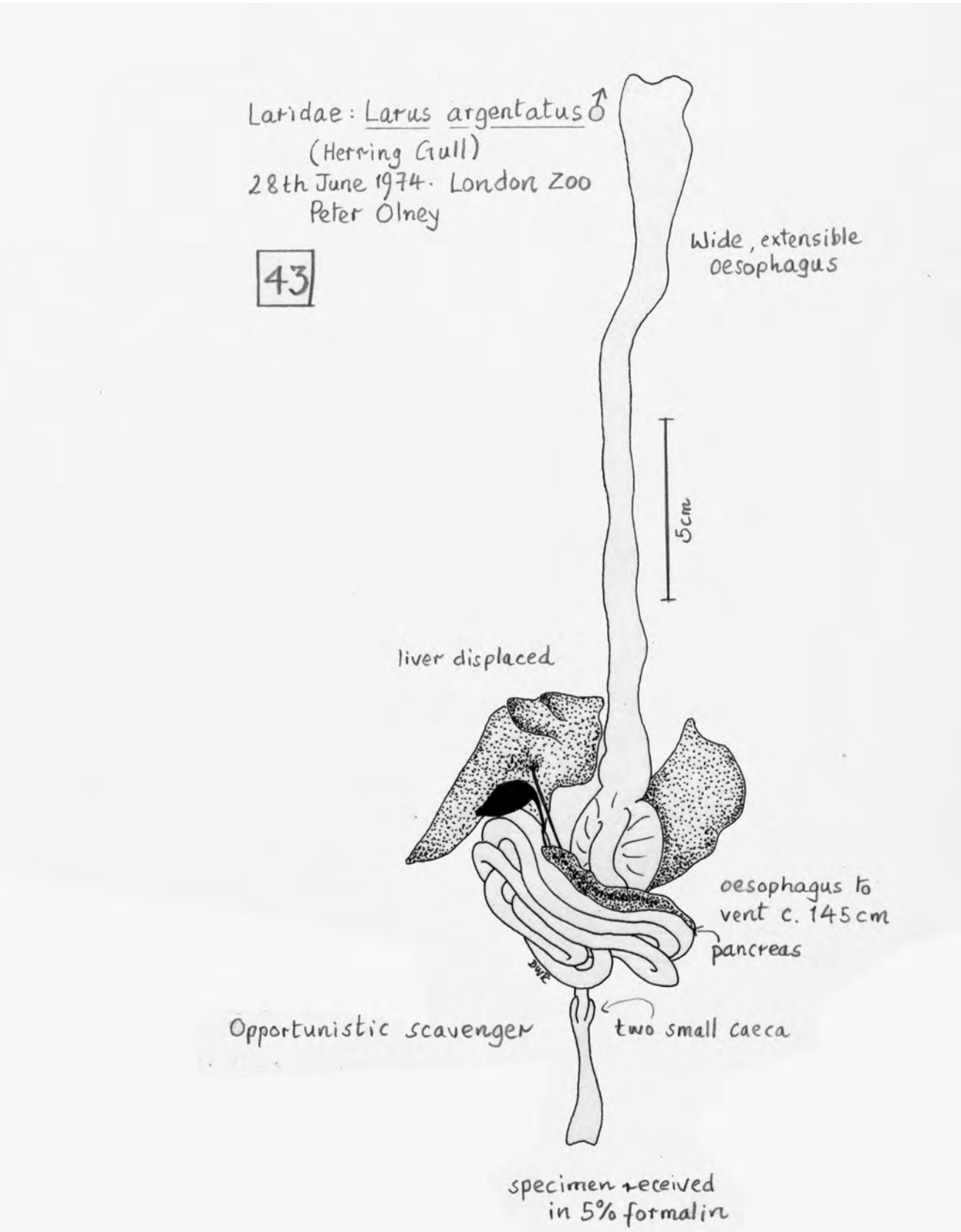
40 *Calidris minutilla* (Least Sandpiper)



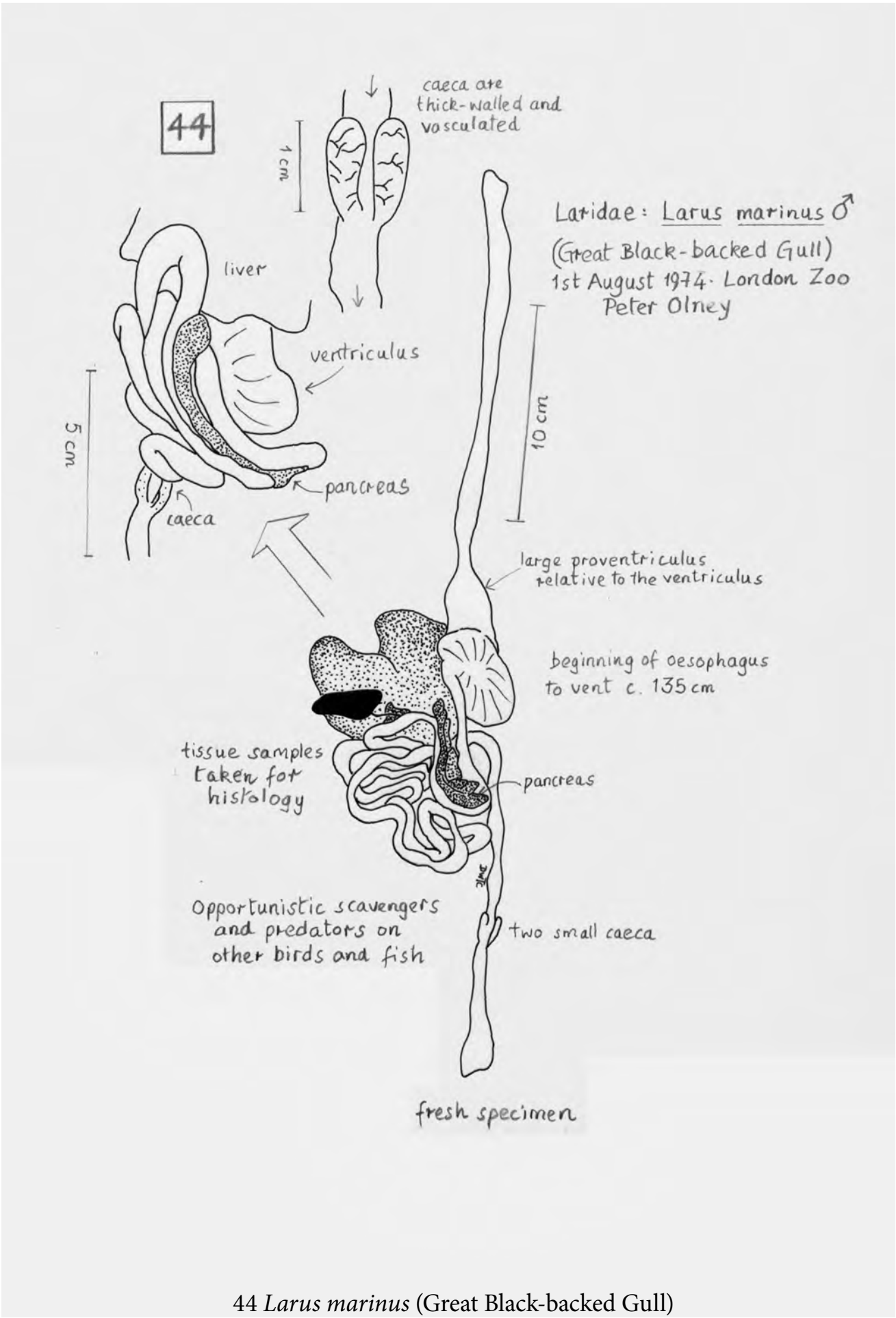
41 *Calidris alpina* (Dunlin)



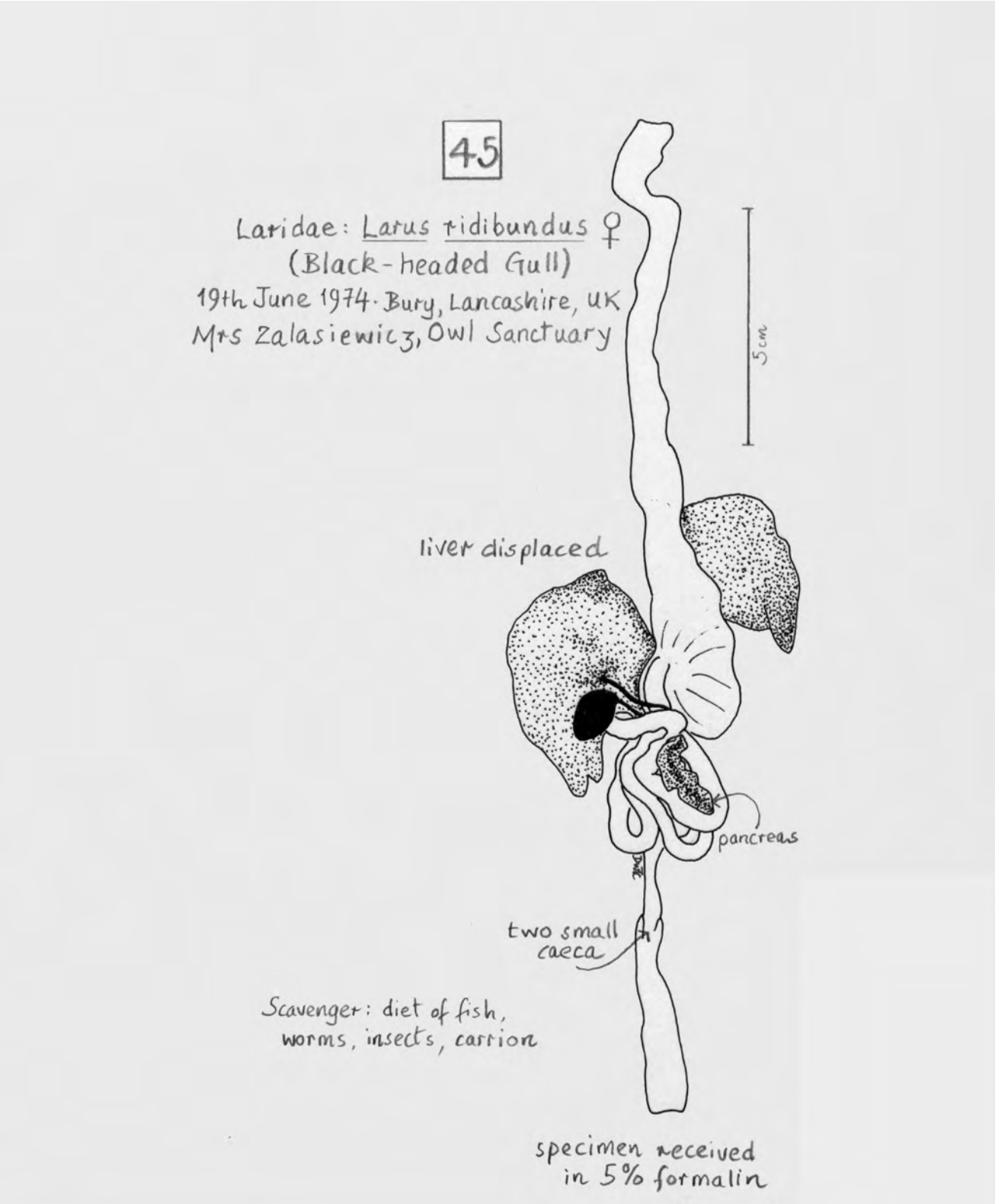
42 *Catharacta skua* (Great Skua "Bonxie")



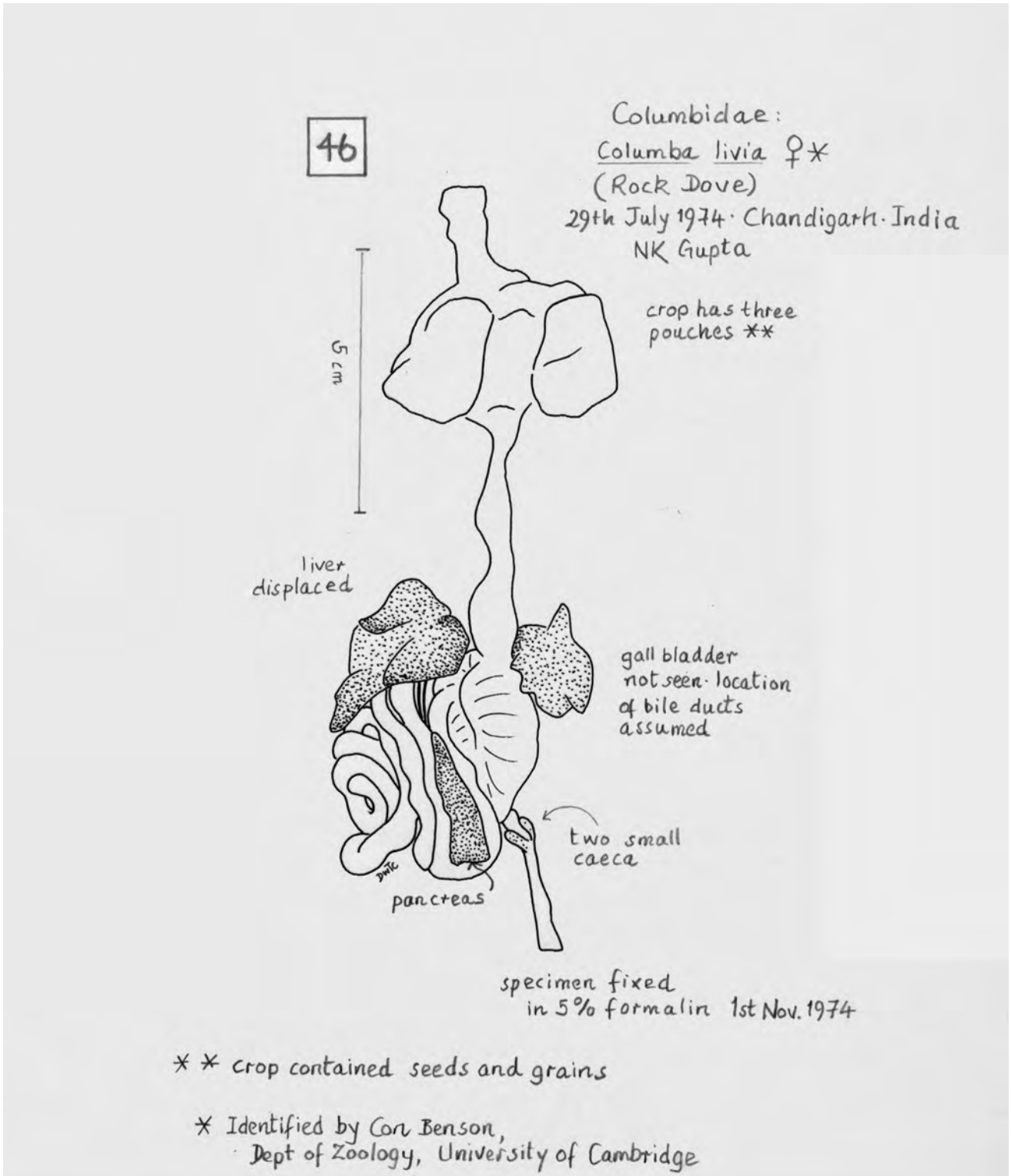
43 *Larus argentatus* (Herring Gull)



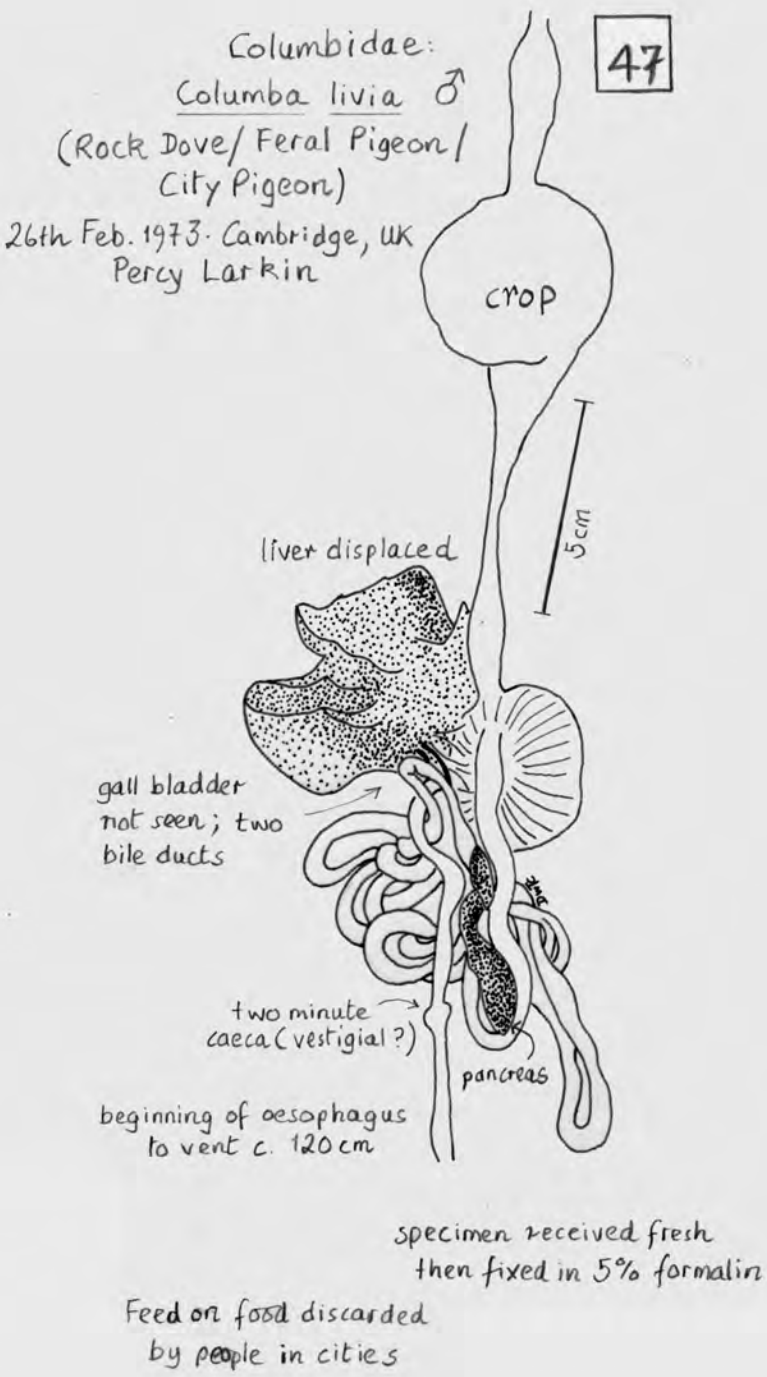
44 *Larus marinus* (Great Black-backed Gull)



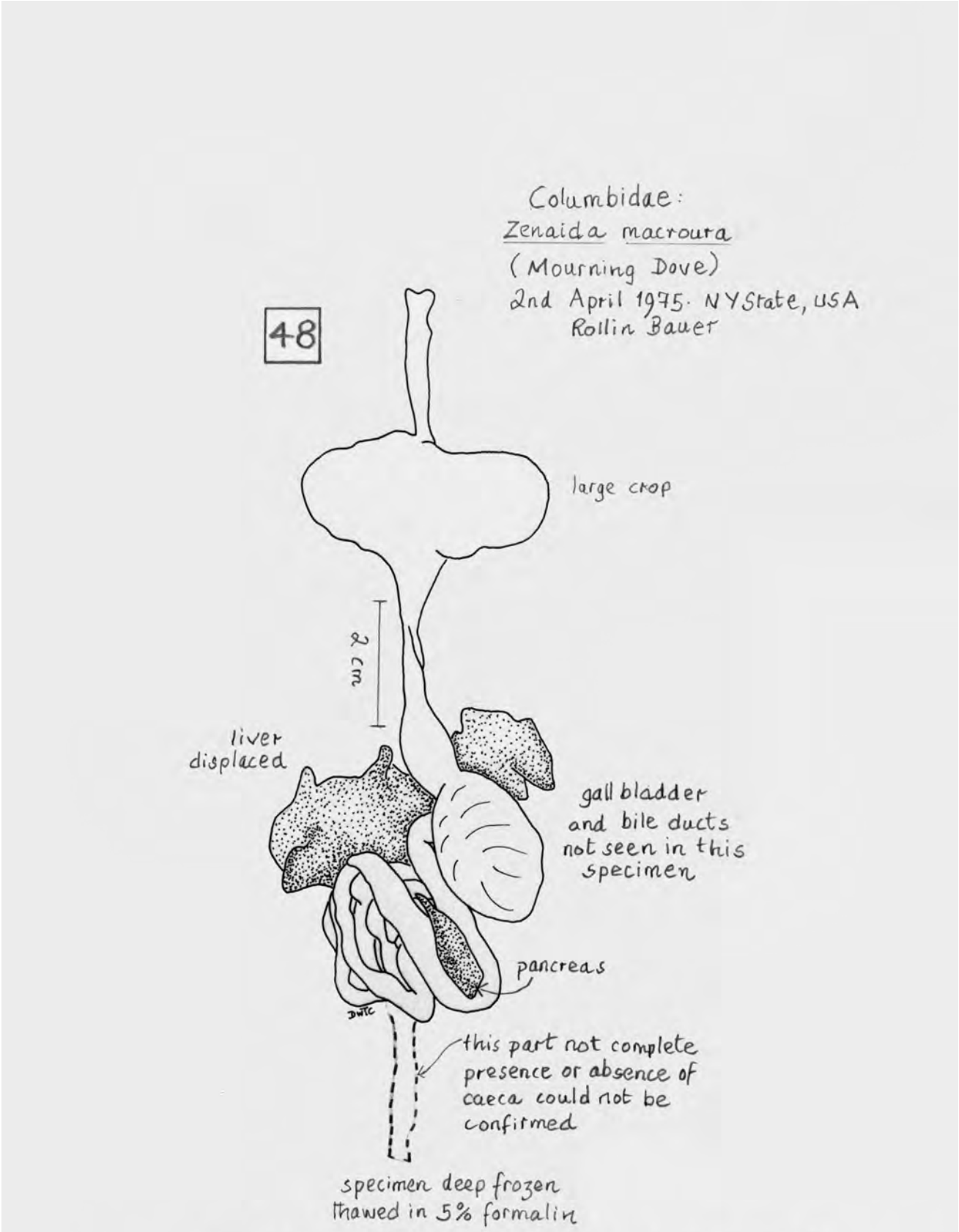
45 *Laus ridibundus* (Black-headed Gull)



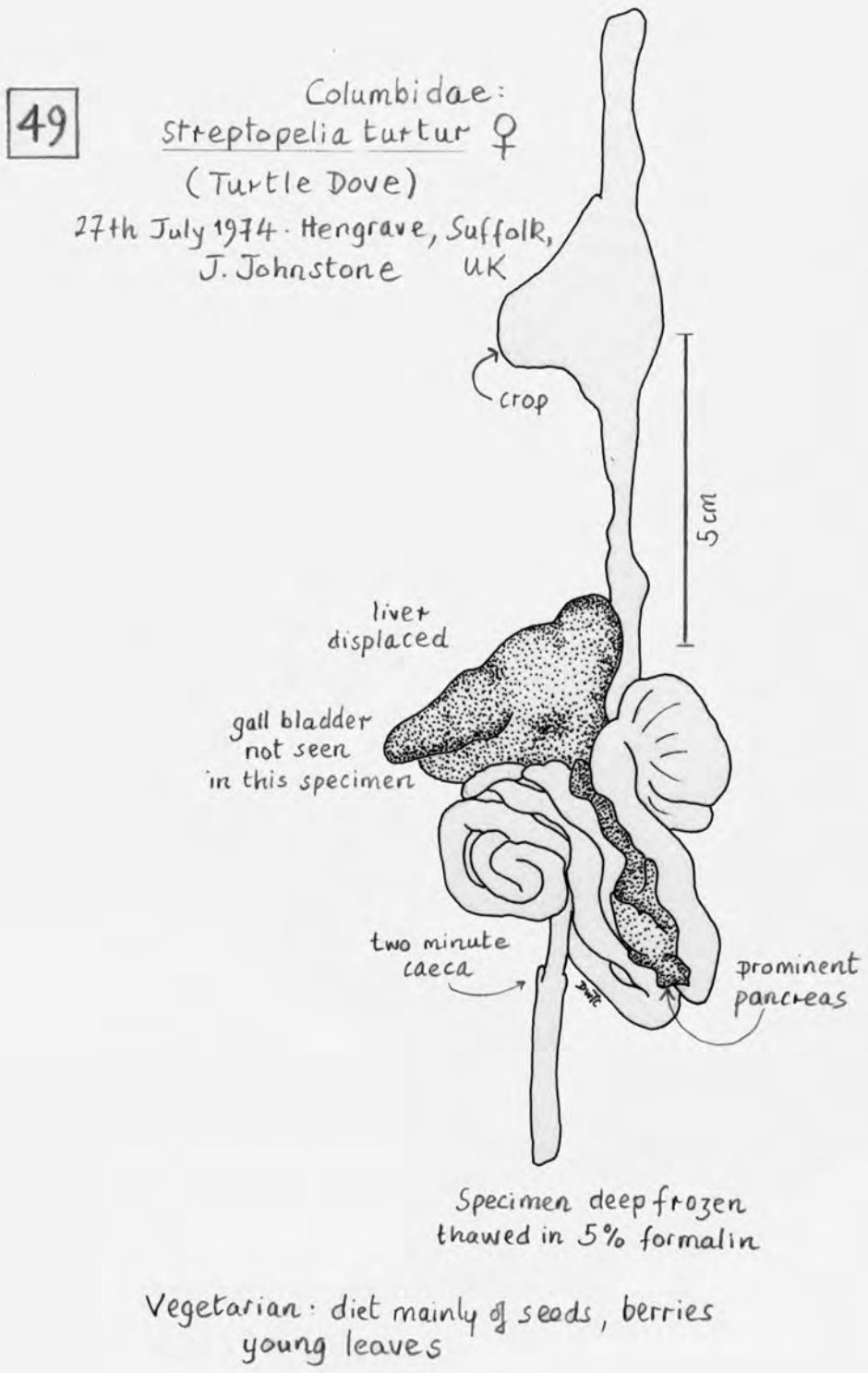
46 *Columba livia* (Rock Dove from India)



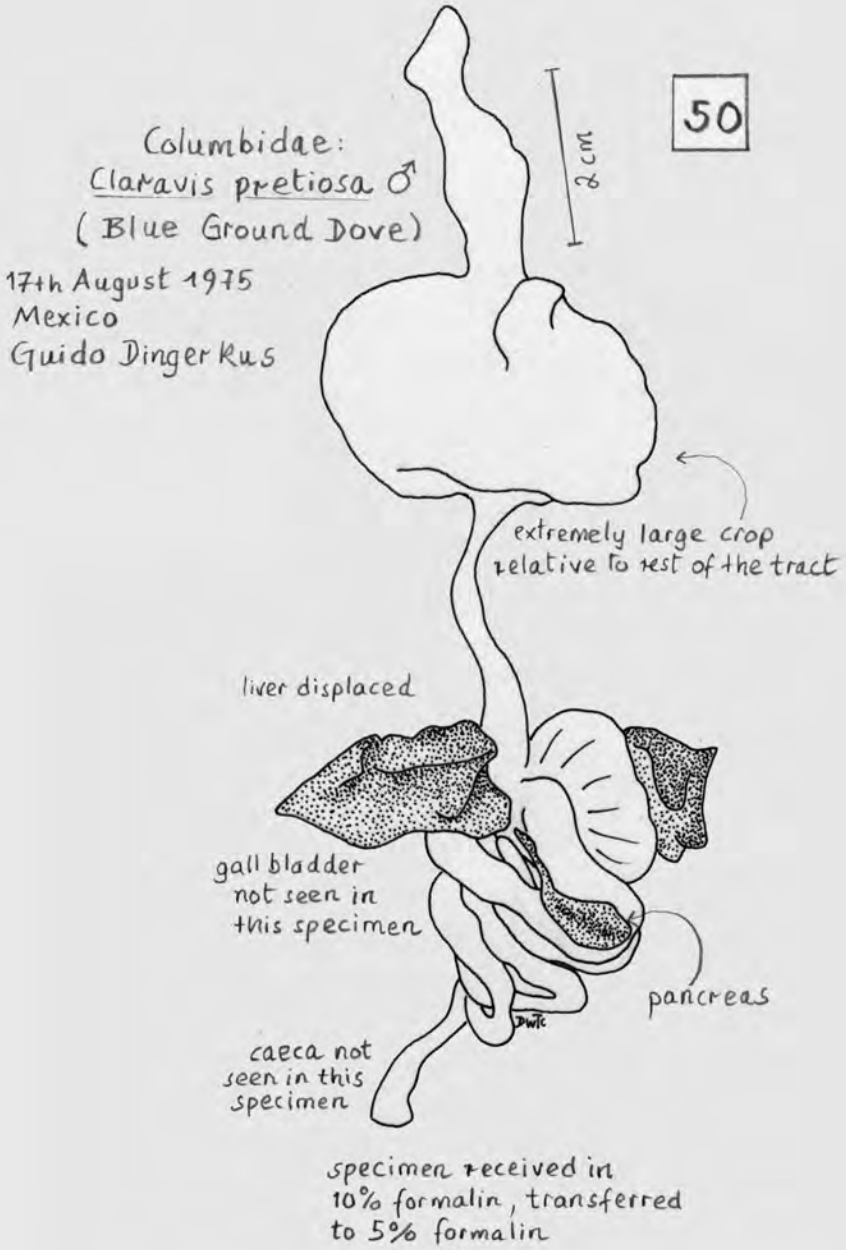
47 *Columba livia* (Rock Dove: Ferai Pigeon/City Pigeon)



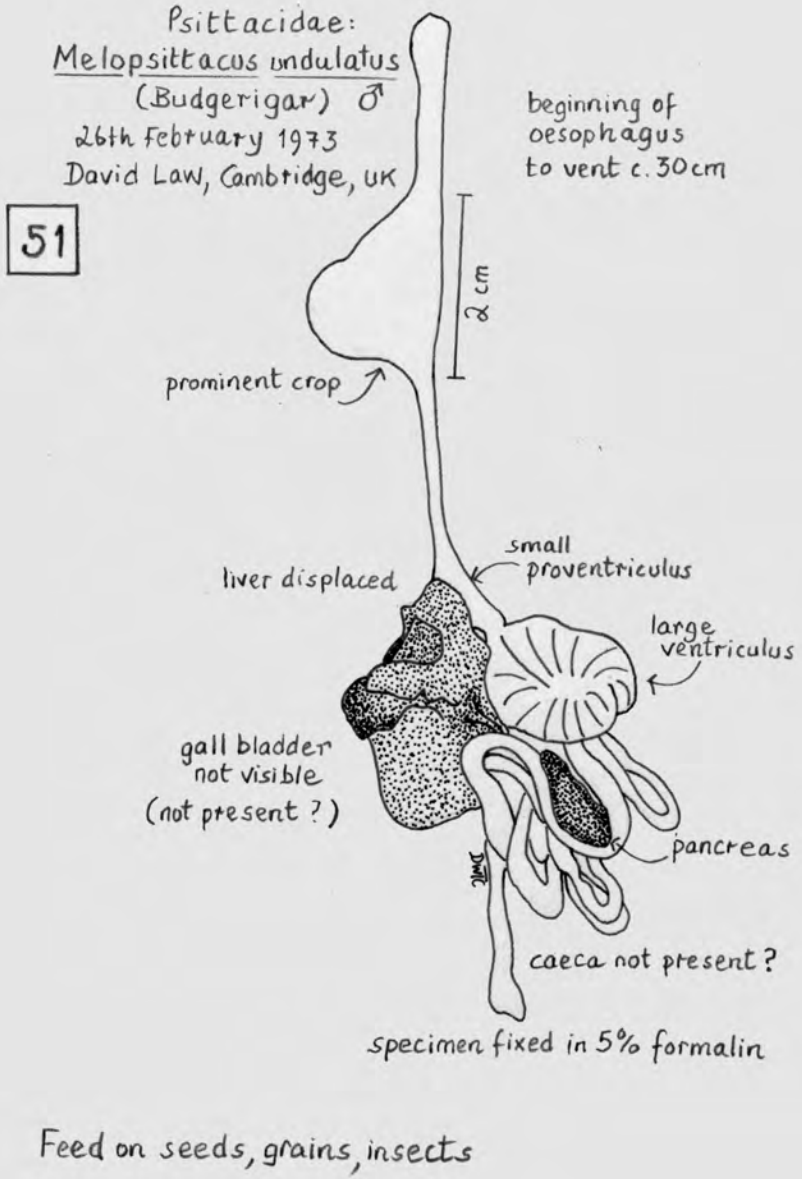
48 *Zenaida macroura* (Mourning Dove)



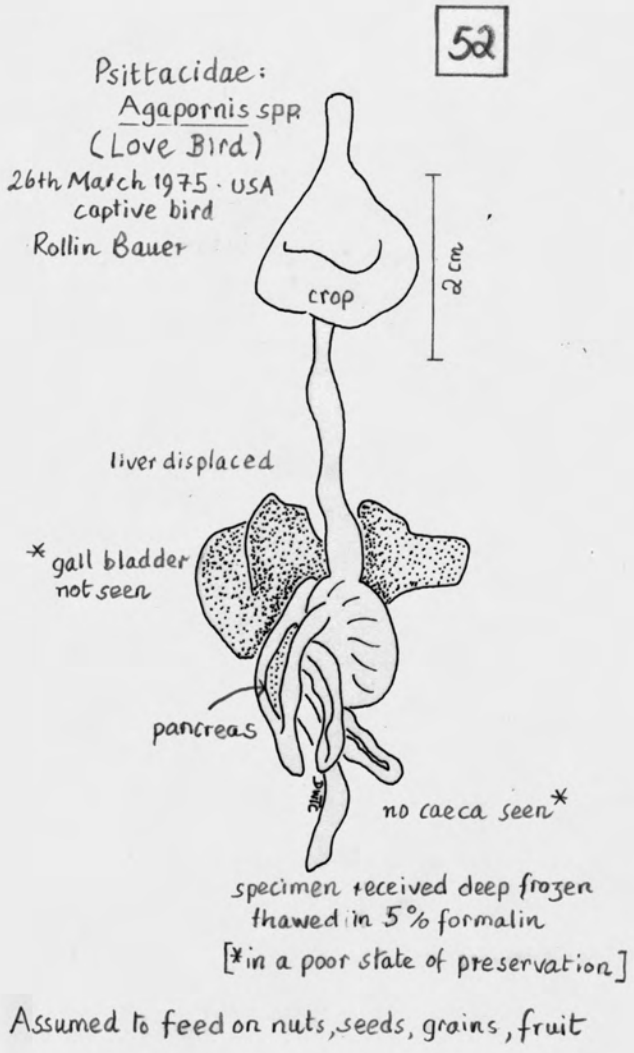
49 Streptopelia turtur (Turtle Dove)



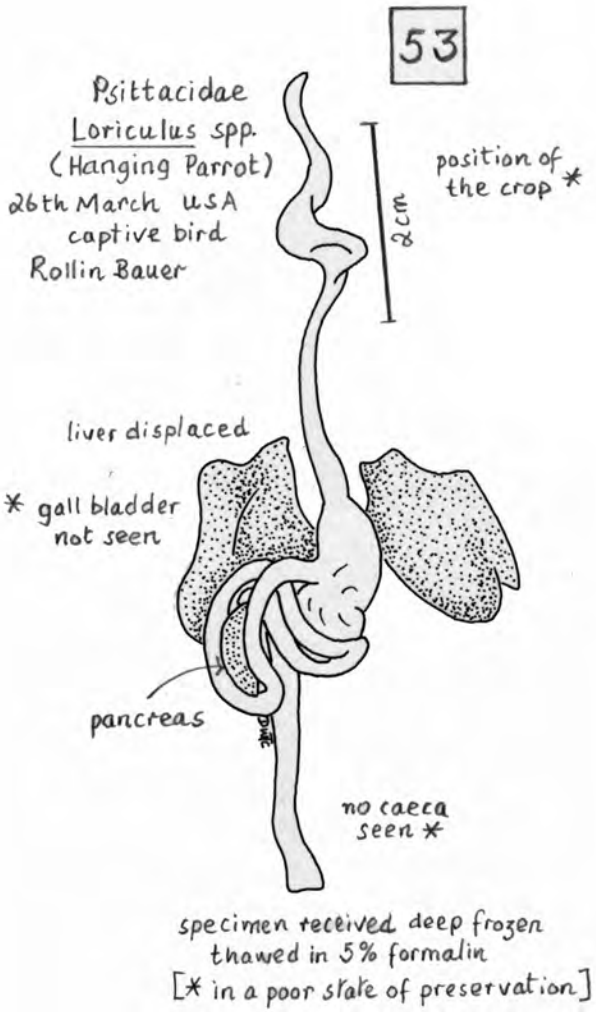
50 *Claravis pretiosa* (Blue Ground Dove)



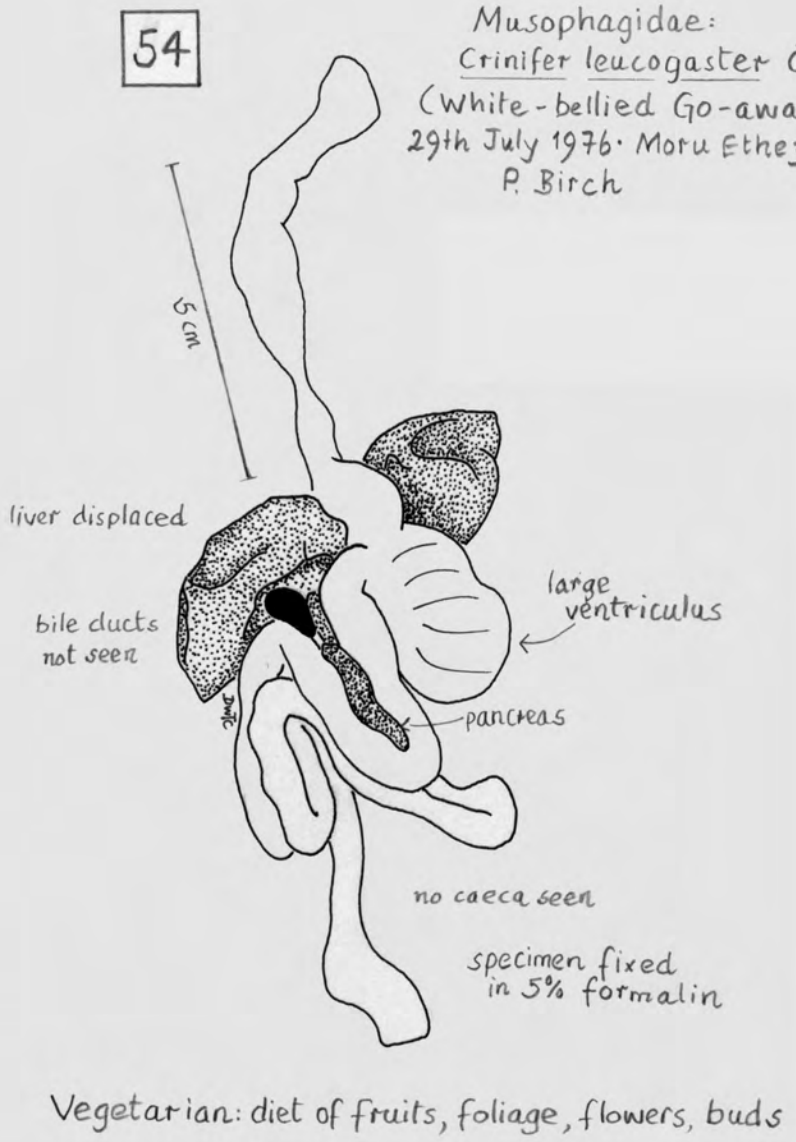
51 *Melopsittacus undulates* (Budgerigar)



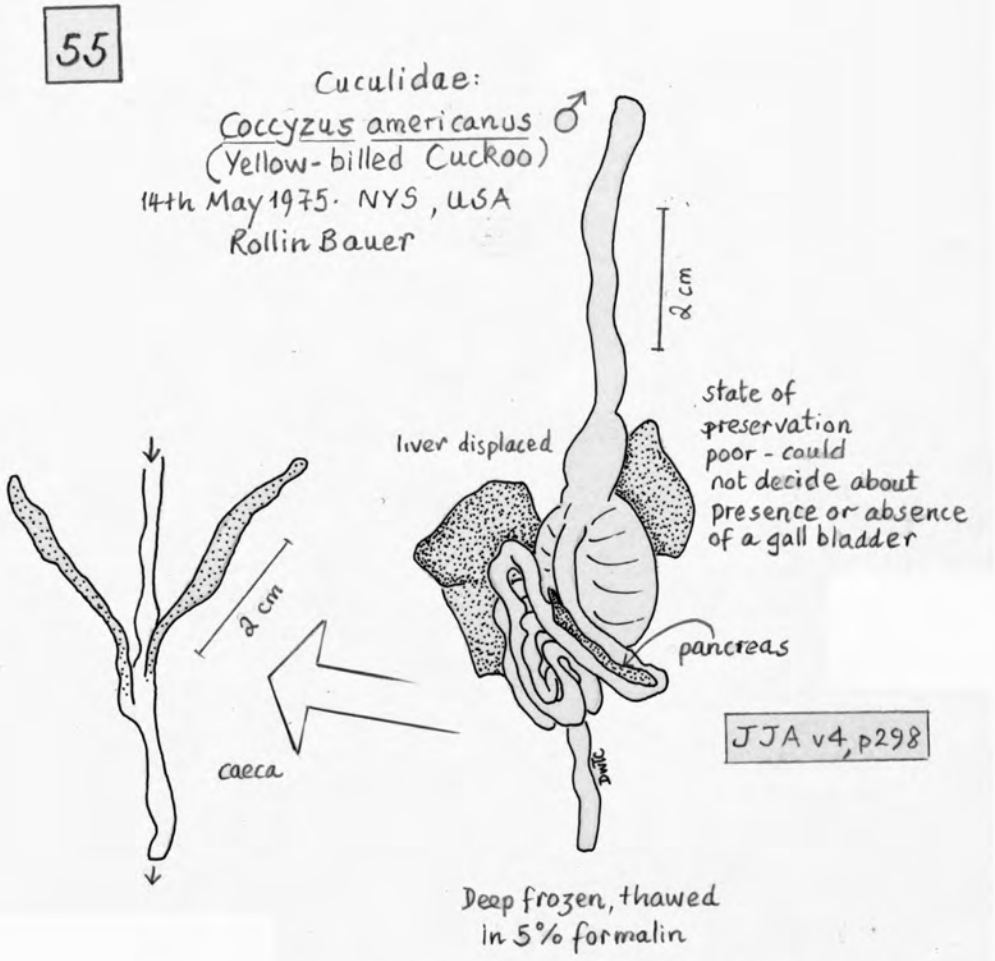
52 *Agapornis spp.* (Love Bird)



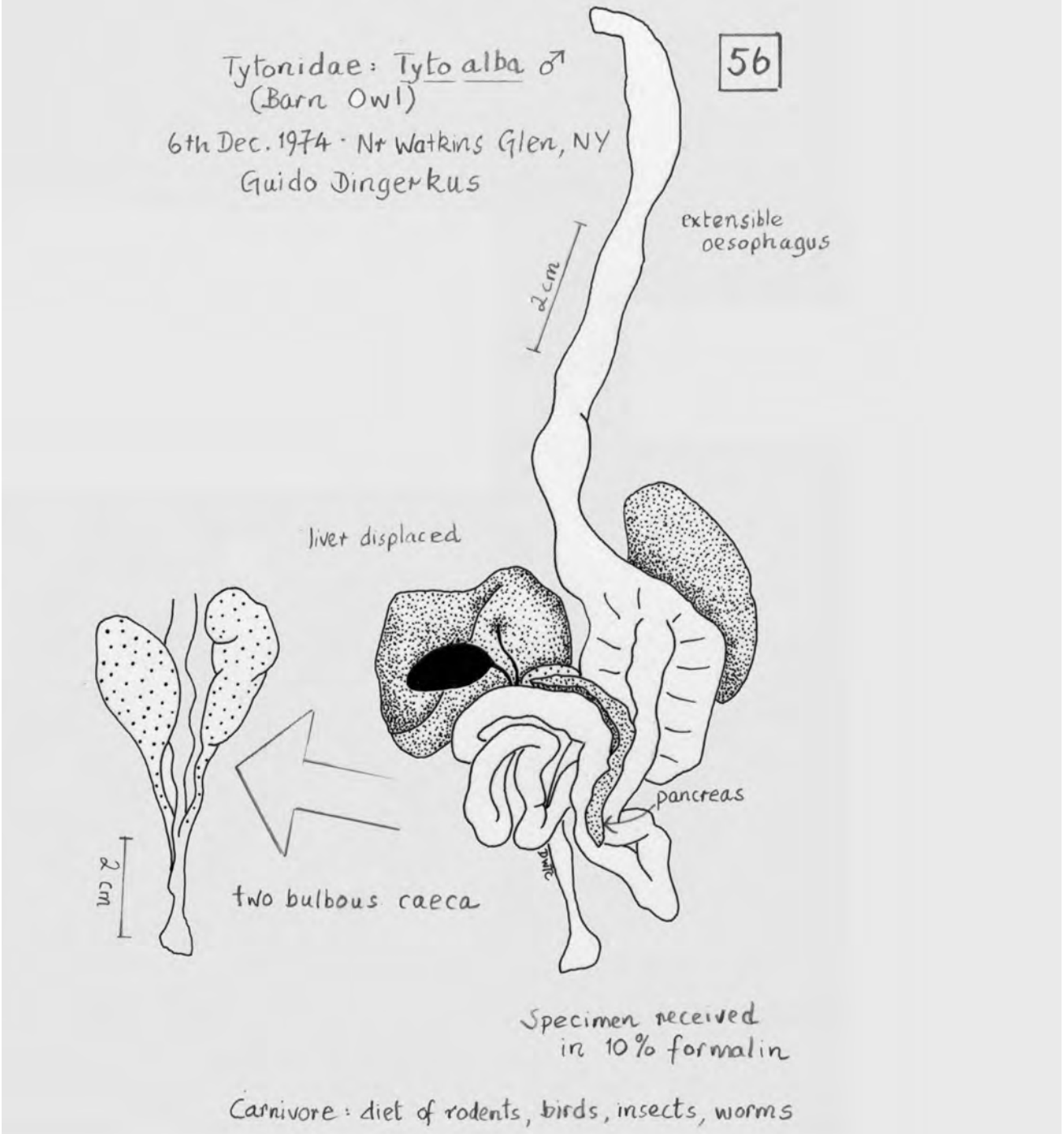
53 *Loriculus spp.* (Hanging Parrot)



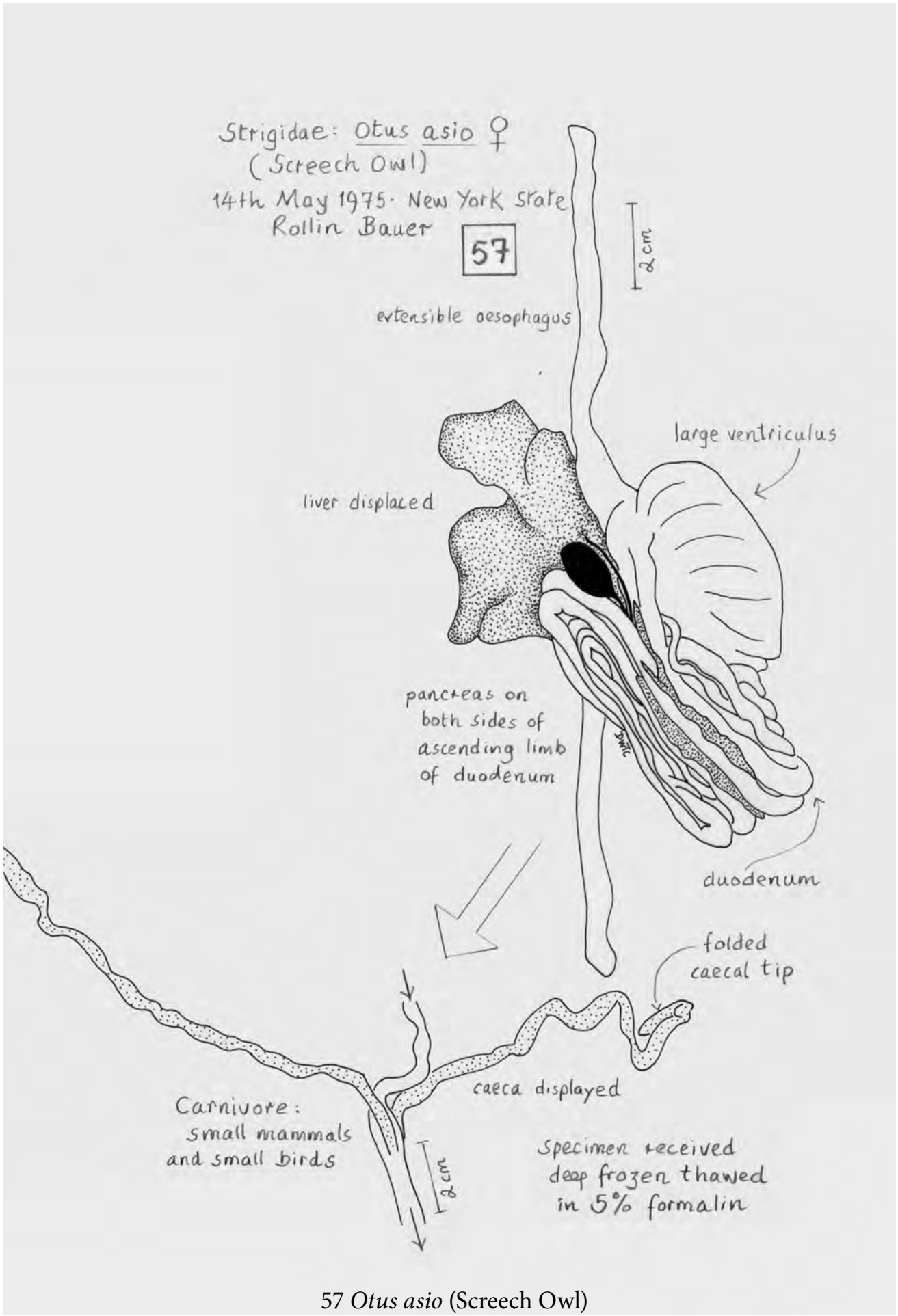
54 *Crinifer leucogaster* (White-bellied Go-away Bird)



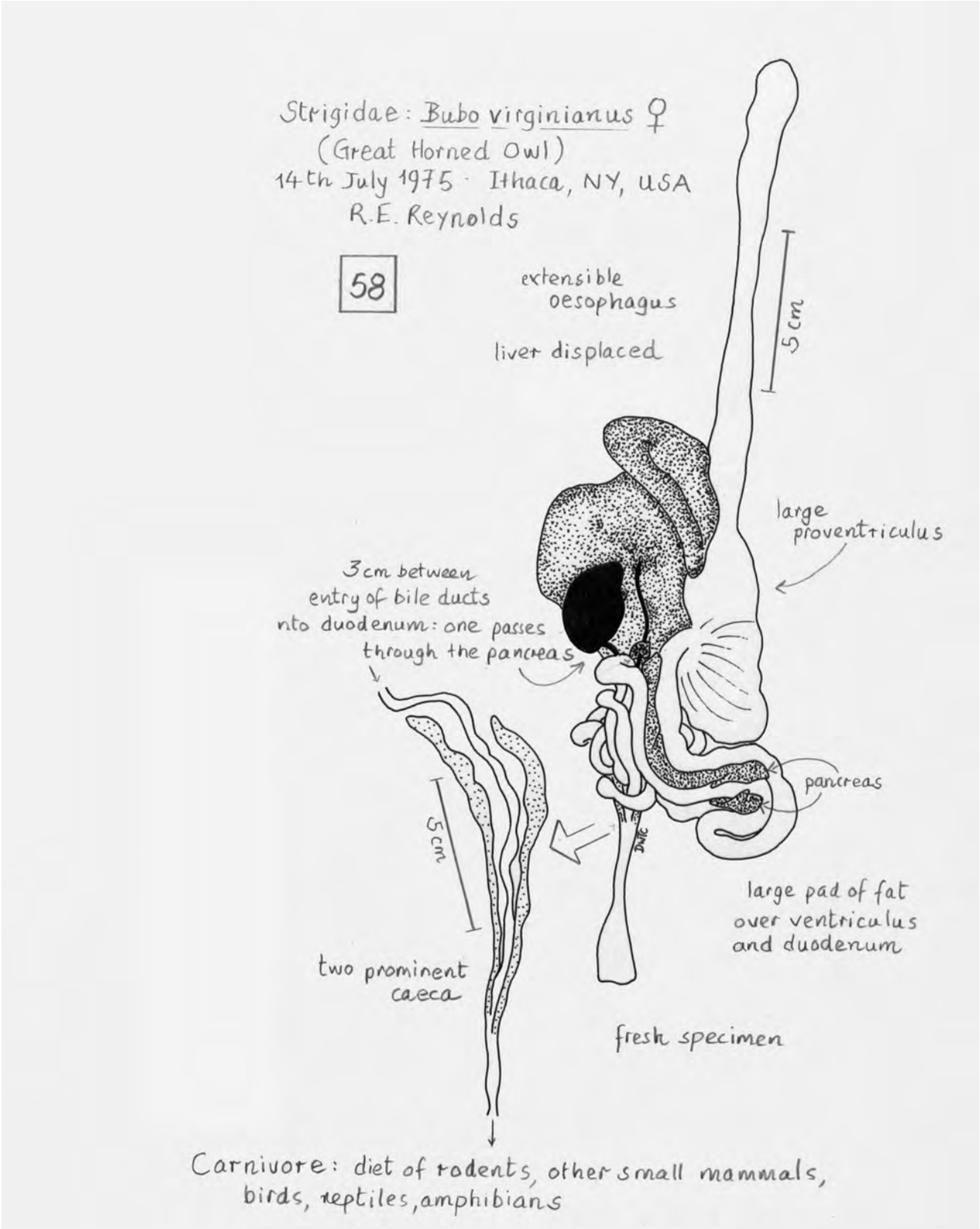
55 *Coccyzus americanus* (Yellow-billed Cuckoo)



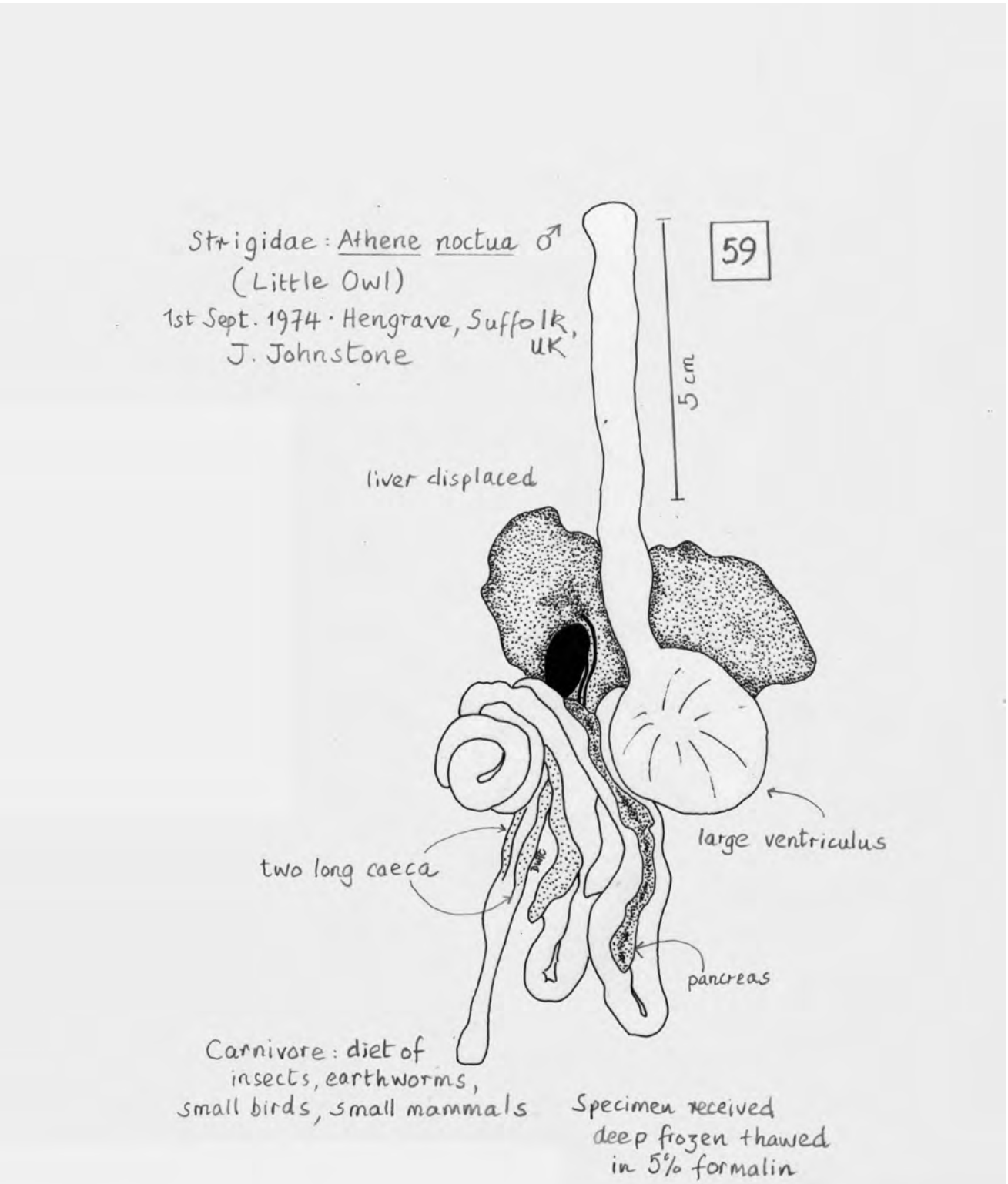
56 *Tyto alba* (Barn Owl)



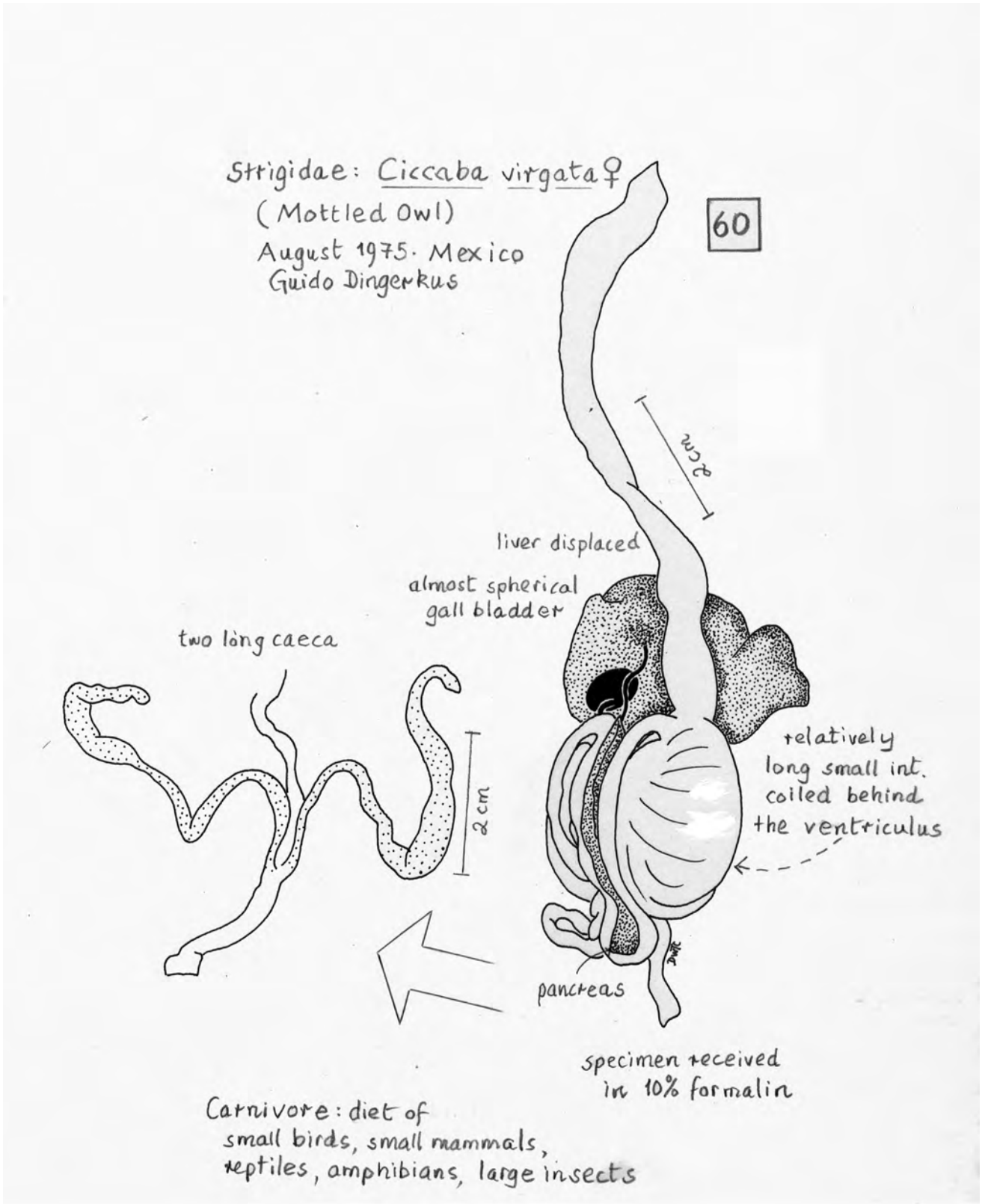
57 *Otus asio* (Screech Owl)



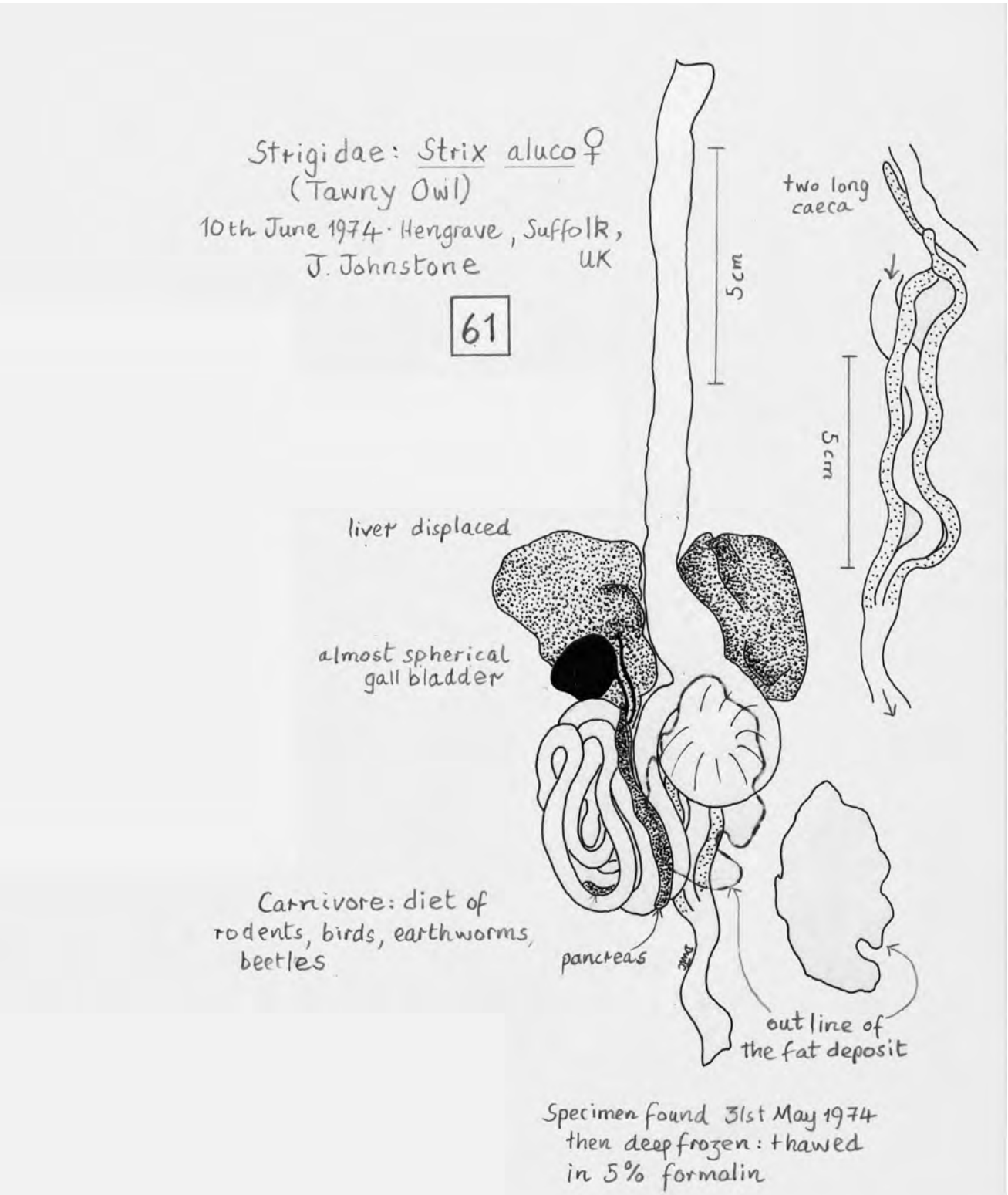
58 *Bubo virginianus* (Great Horned Owl)



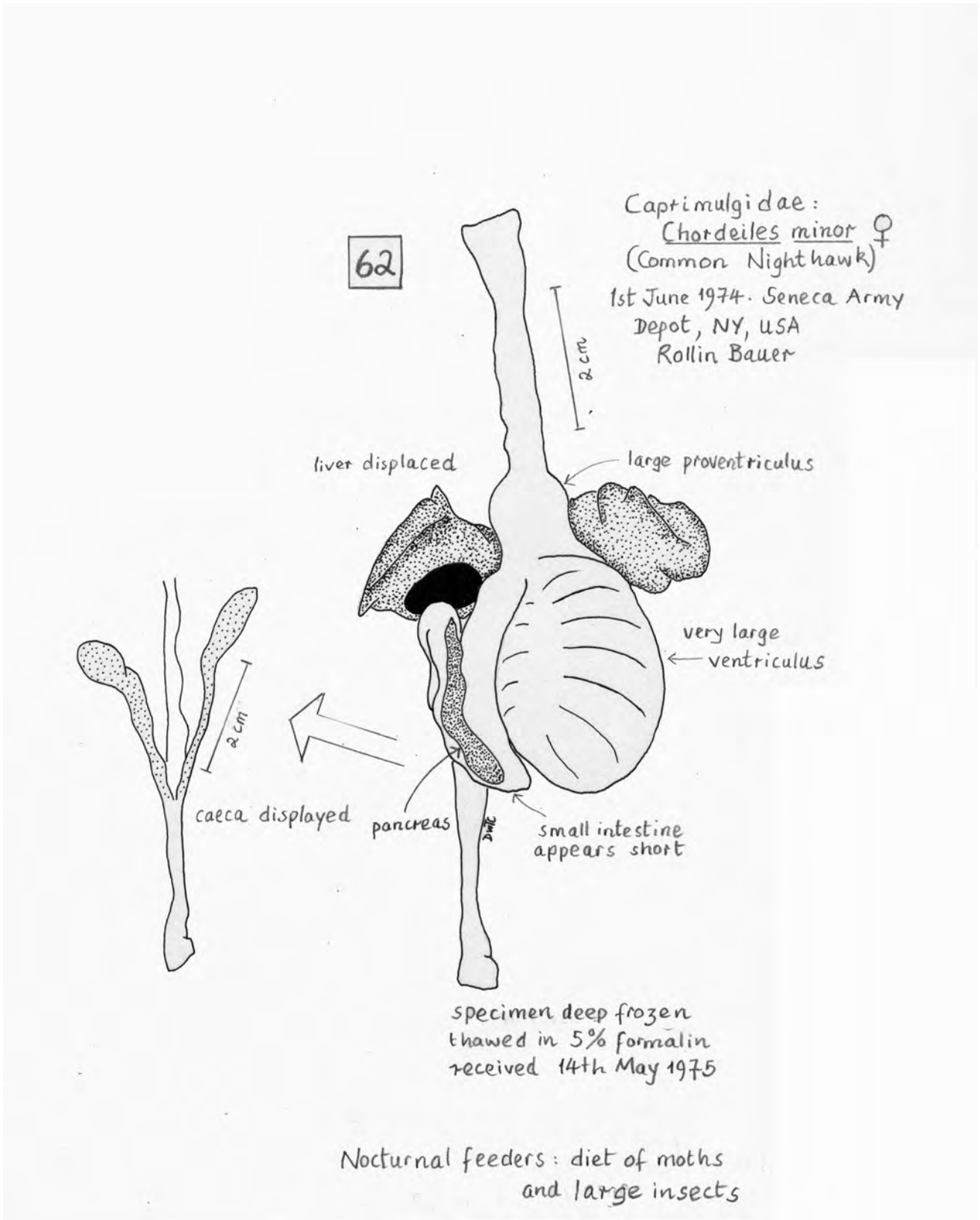
59 Athene noctua (Little Owl)



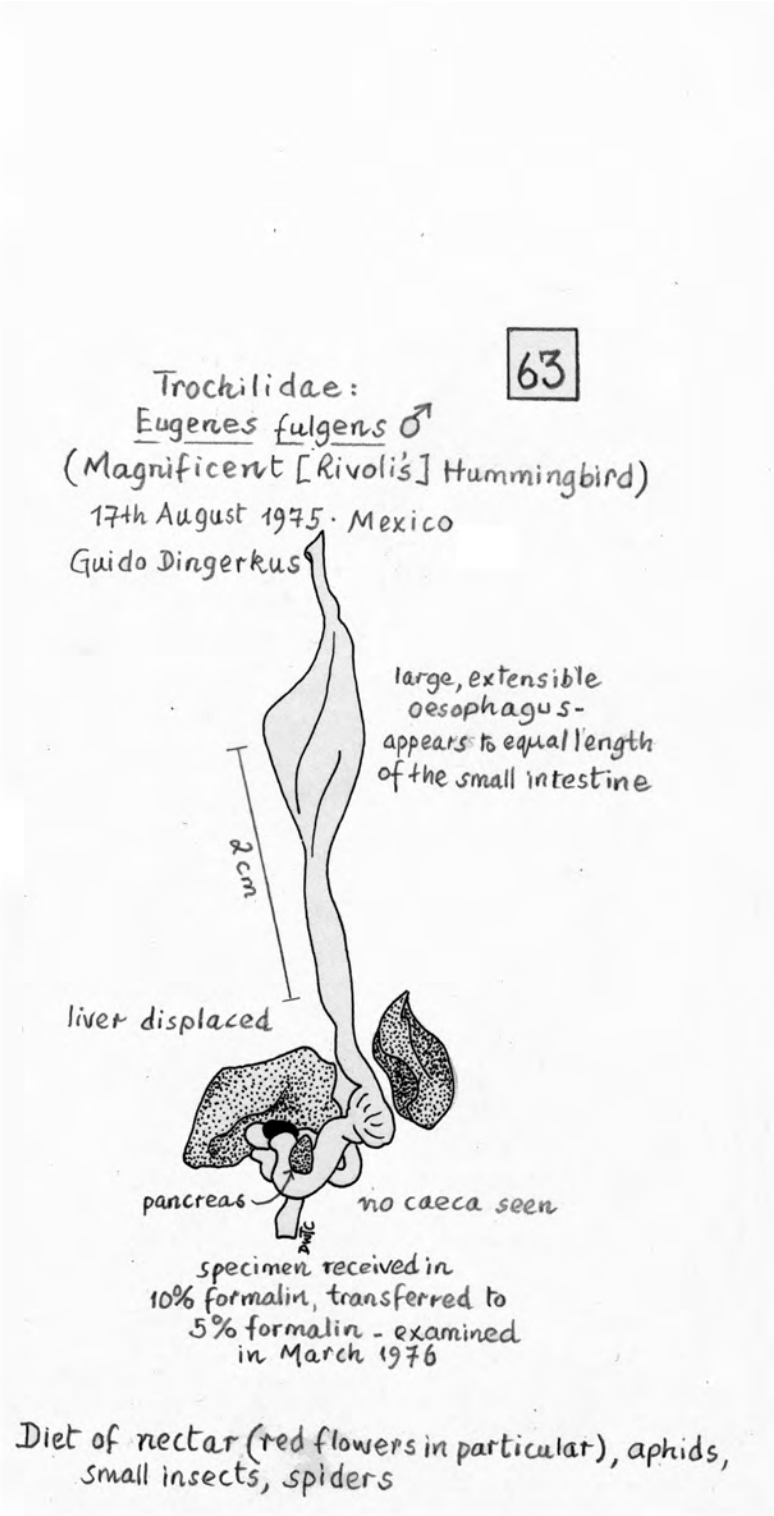
60 *Ciccaba virgata* (Mottled Owl)



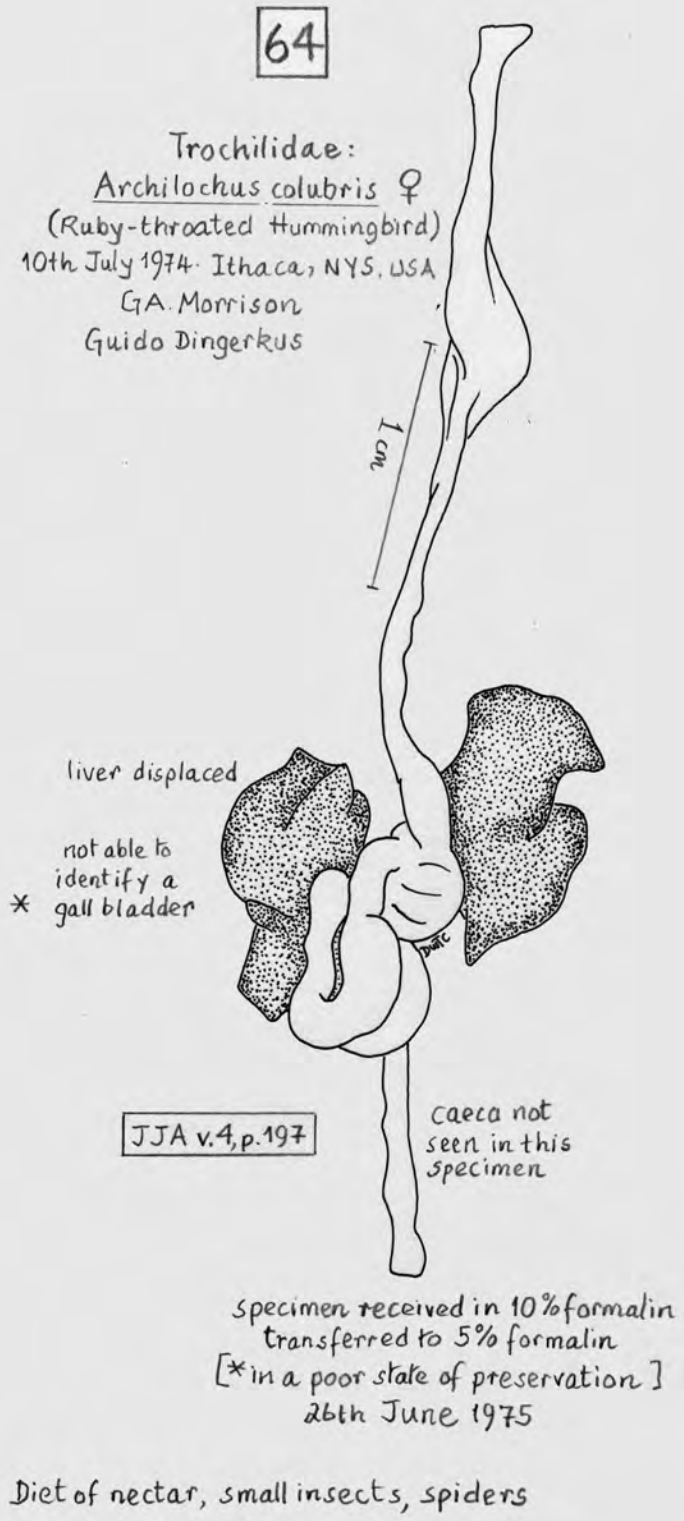
61 *Strix aluco (Tawny Owl)*



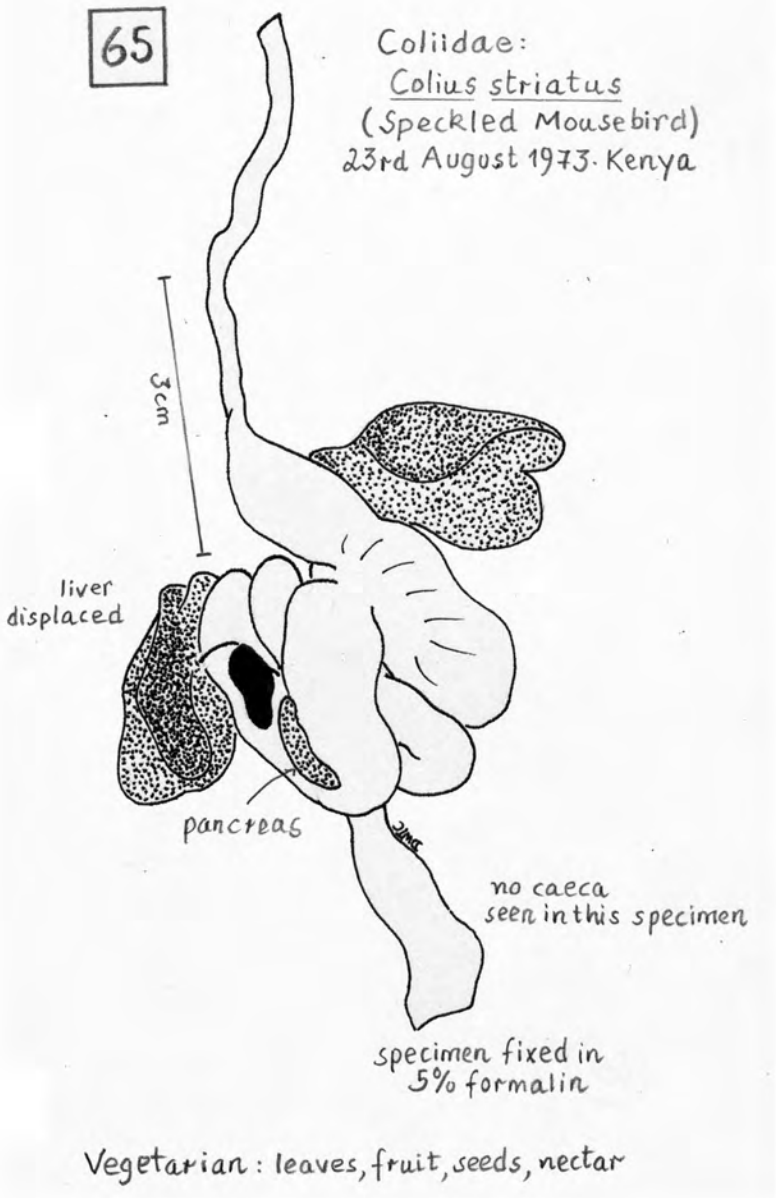
62 *Chordeiles minor* (Common Nighthawk)



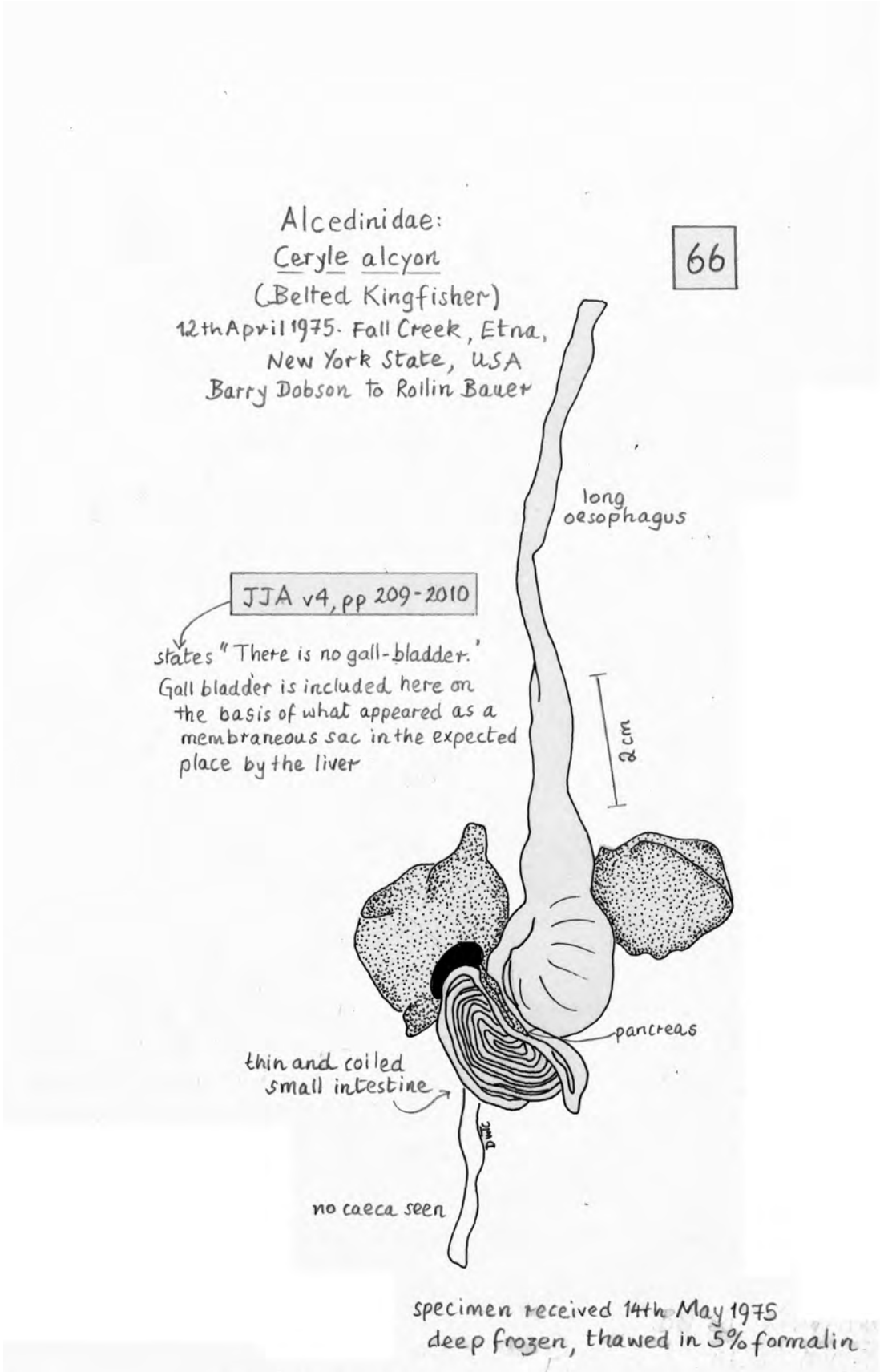
63 *Eugenes fulgens* (Magnificent [Rivoli's] Hummingbird)



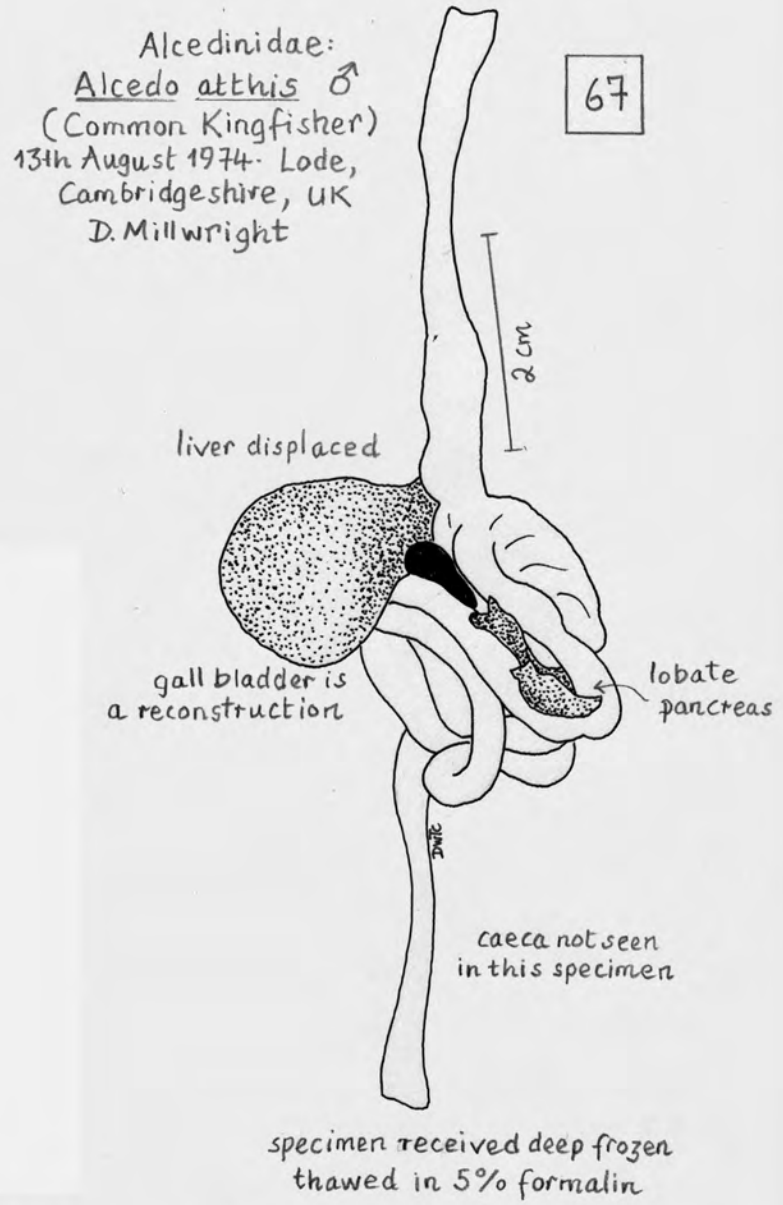
64 *Archilochus colubris* (Ruby-throated Hummingbird)



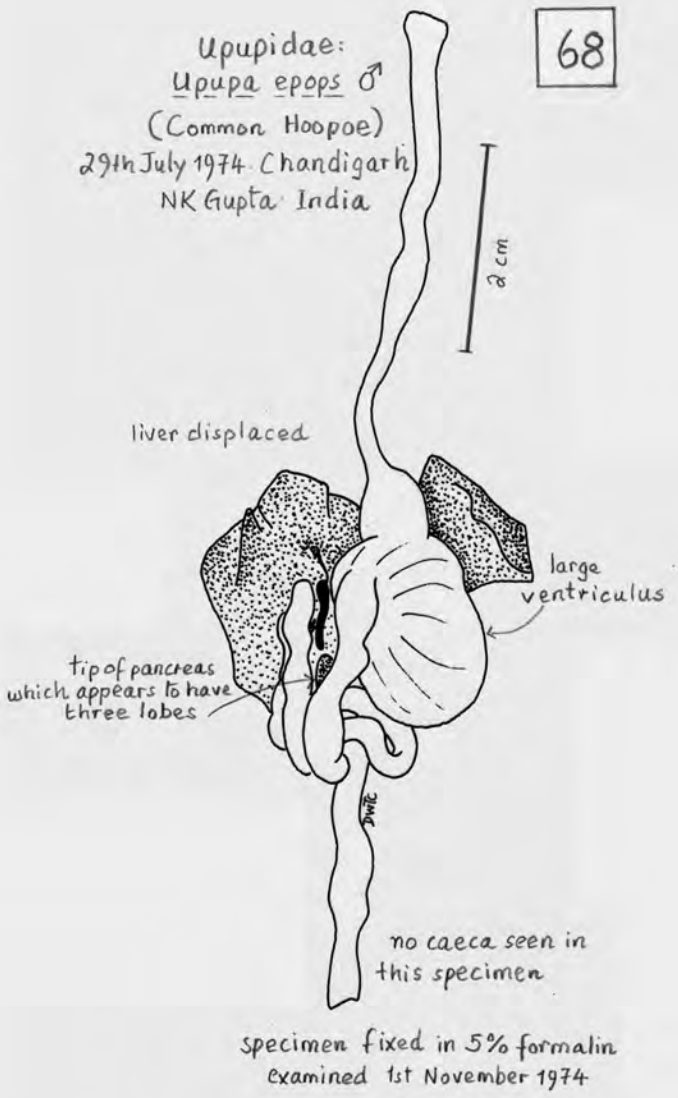
65 *Colius striatus* (Speckled Mousebird)



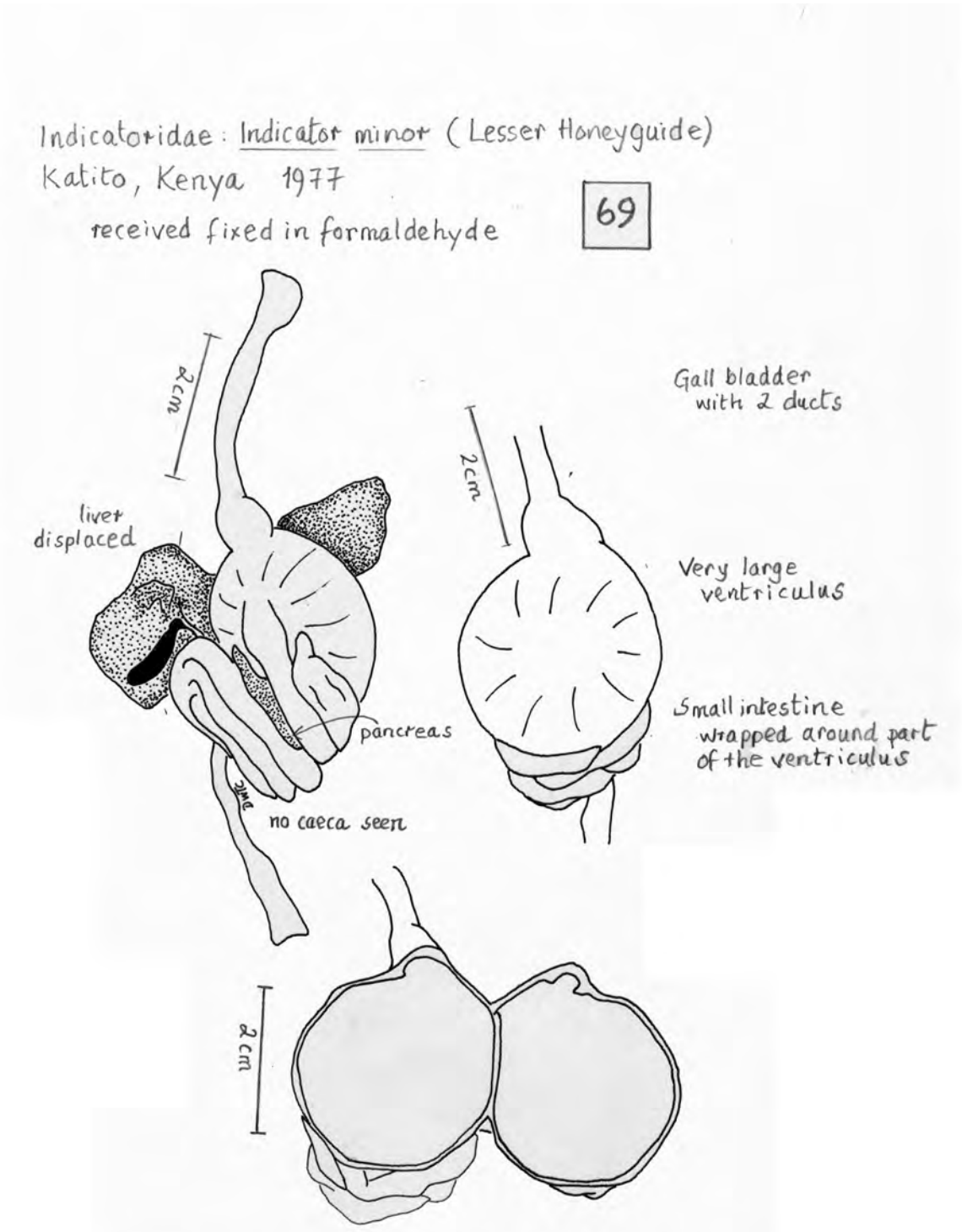
66 *Ceryle alcyon* (Belted Kingfisher)



67 Alcedo atthis (Common Kingfisher)

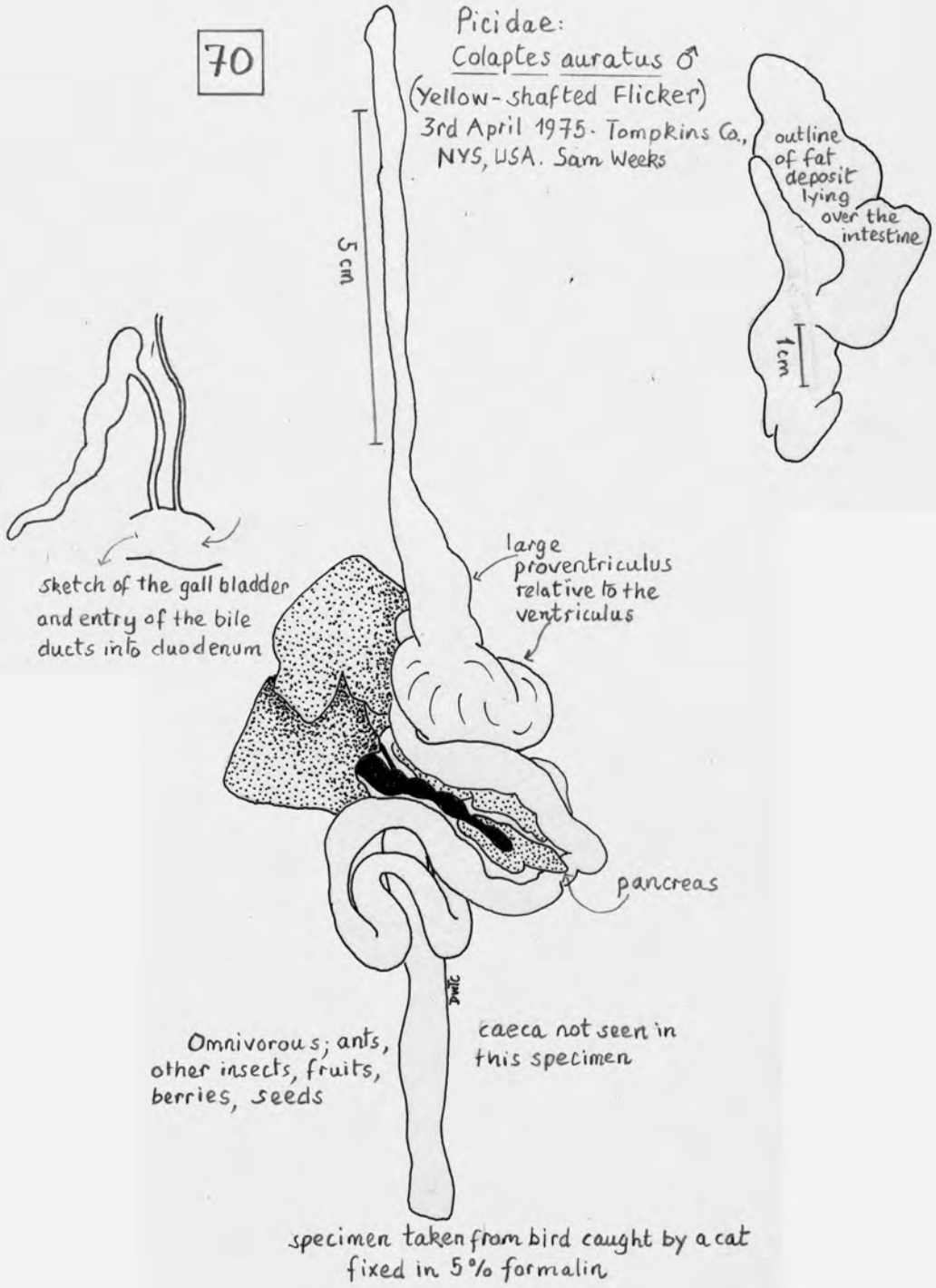


68 Upupa epops (Common Hoopoe)

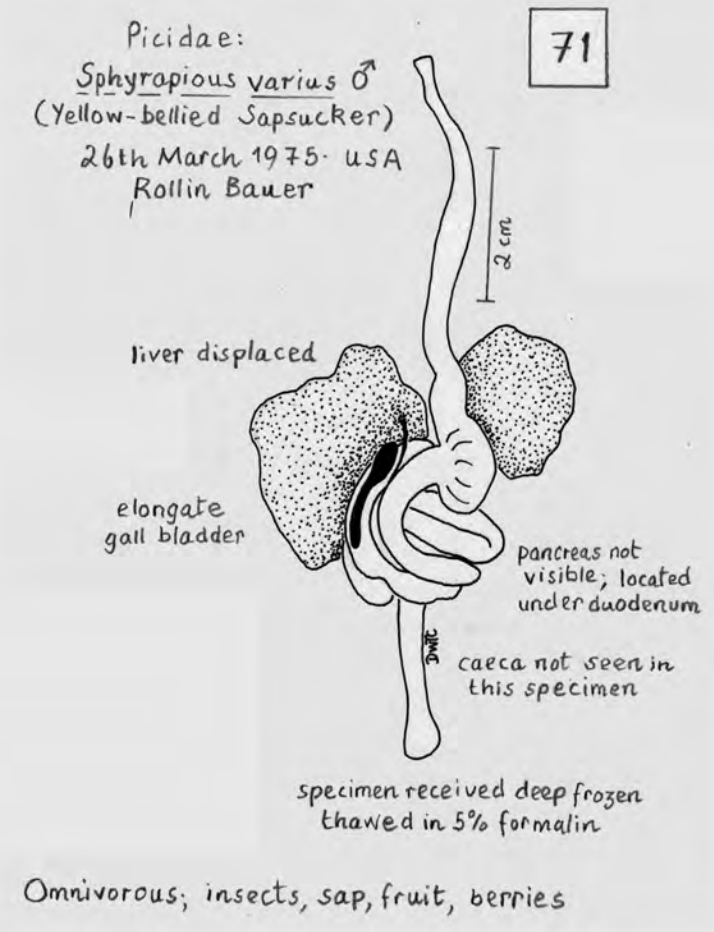


On 12th August 1978 George Mewis examined the contents of the ventriculus (x8.75 mag.). Cocoons were present held together by beeswax. Small lumps of beeswax were also present. A higher magnification (x250) revealed quantities of pollen and silk threads from the cocoons.

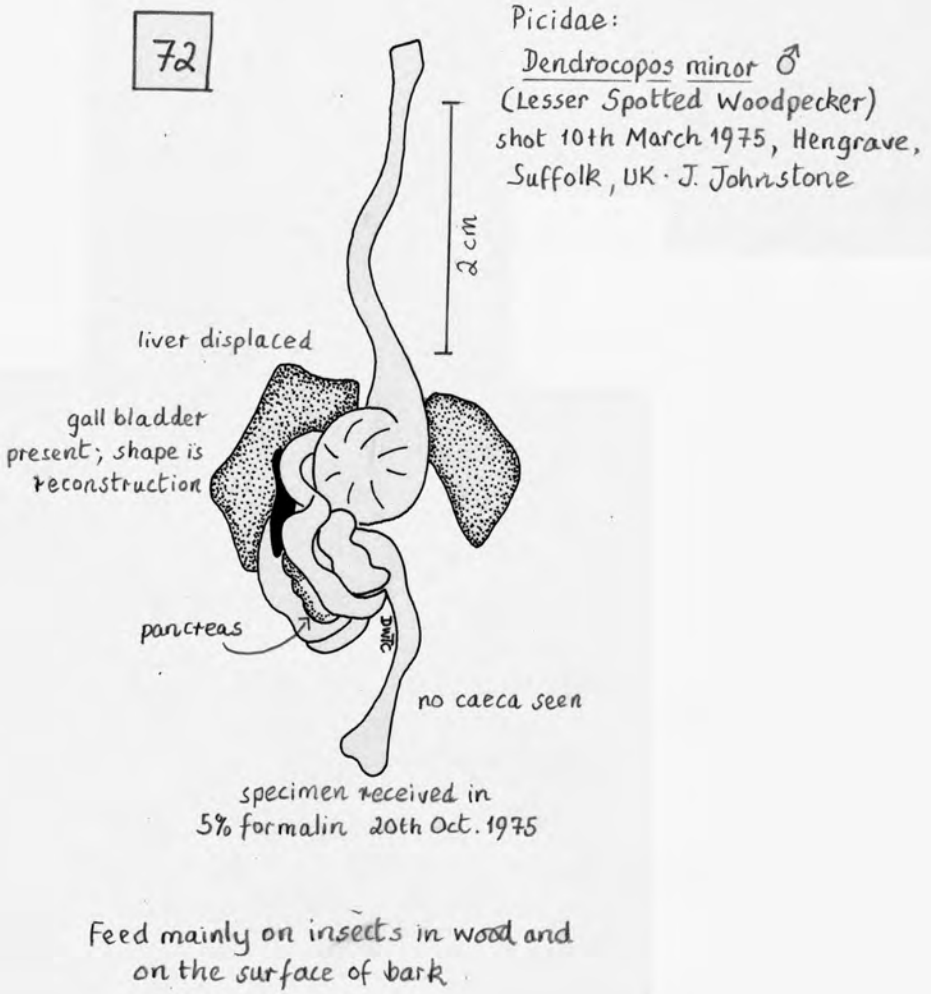
69 Indicator minor (Lesser Honeyguide)



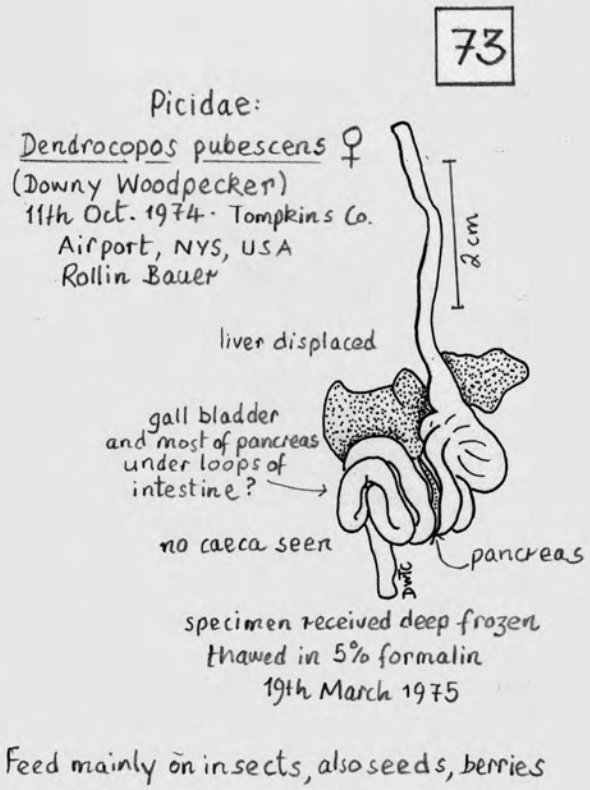
70 *Colaptes auratus* (Yellow-shafted Flicker/Common Flicker)



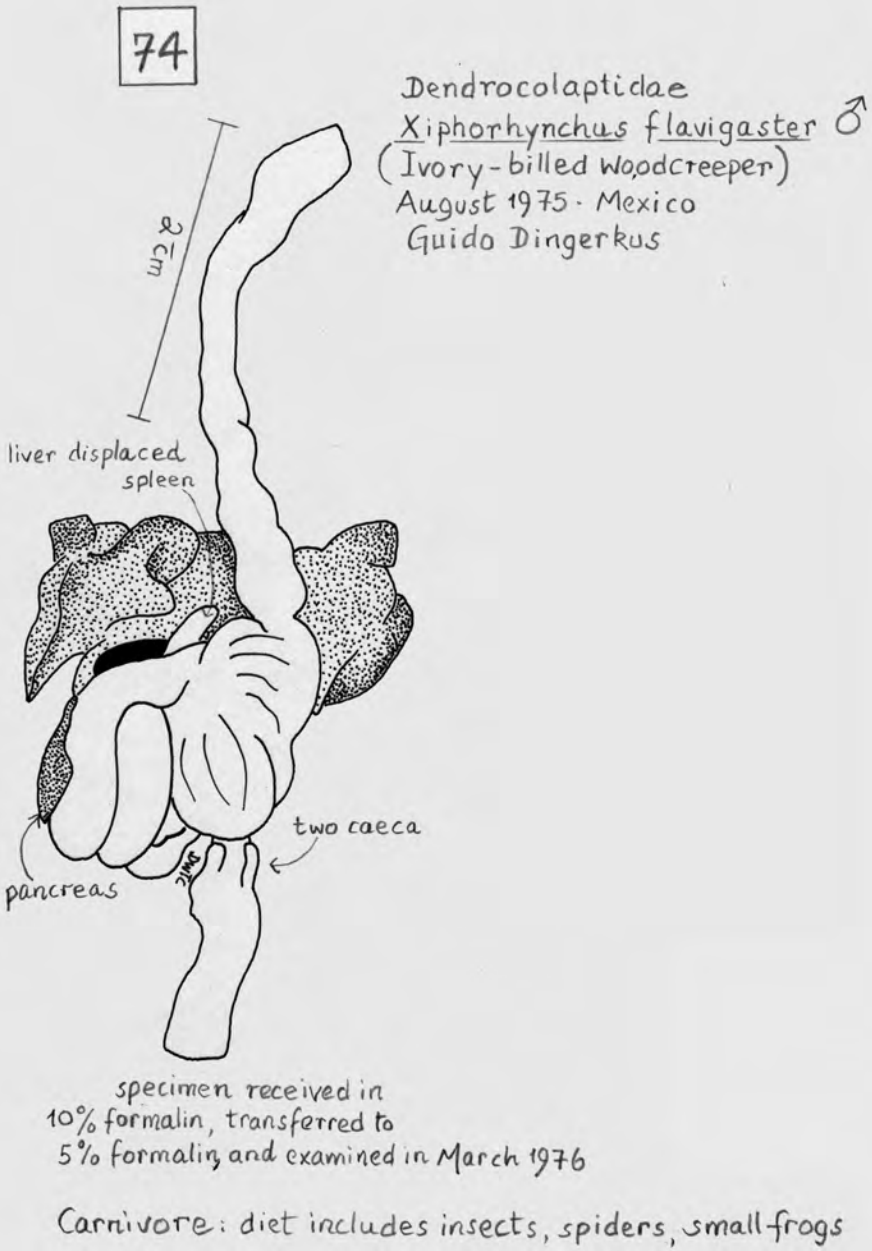
71 *Sphyrapious varius* (Yellow-bellied Sapsucker)



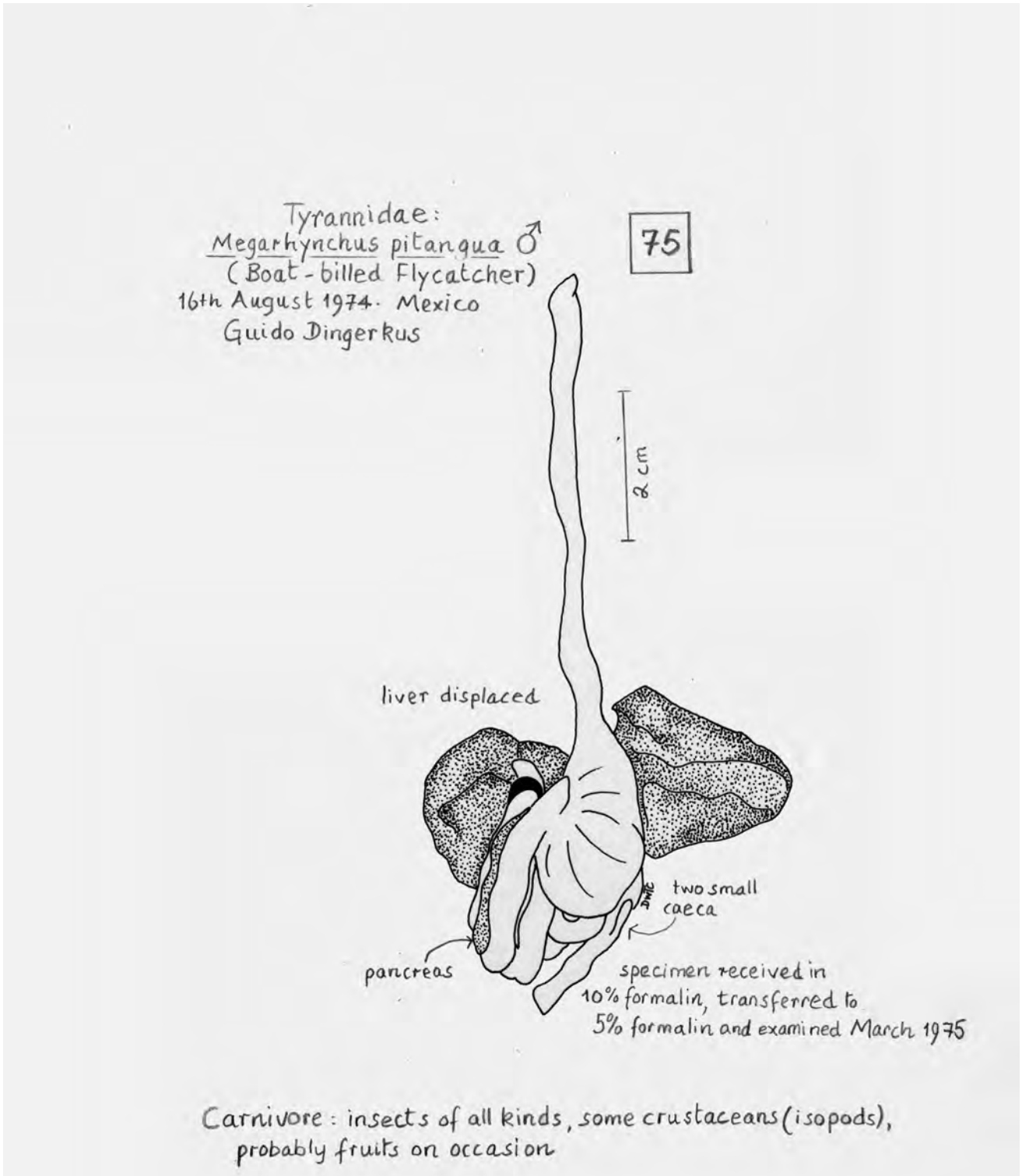
72 *Dendrocopos minor* (Lesser Spotted Woodpecker)



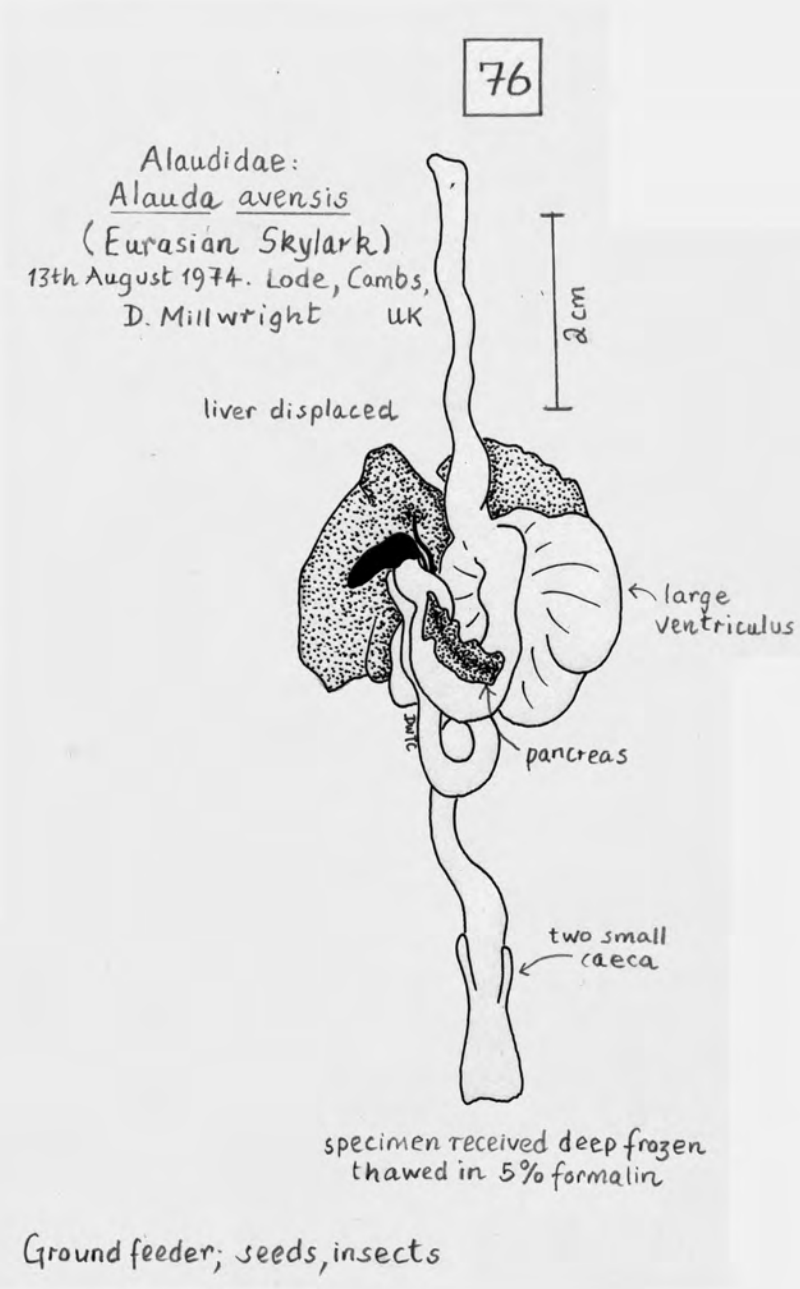
73 Dendrocopos pubescens (Downy Woodpecker)



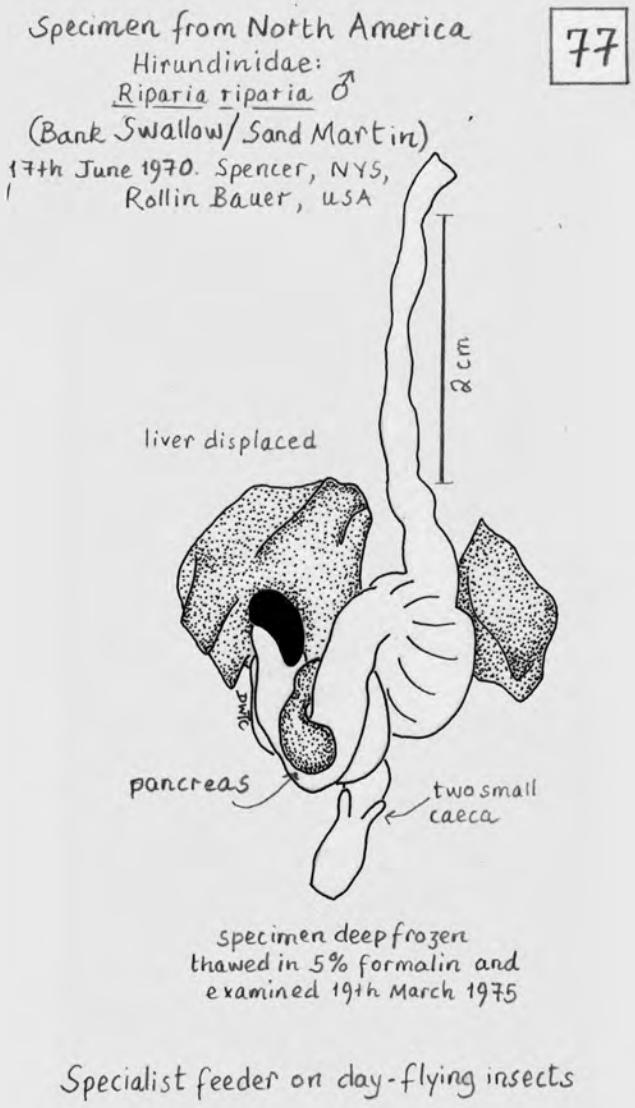
74 *Xiphorhynchus flavigaster* (Ivory-billed Woodcreeper)



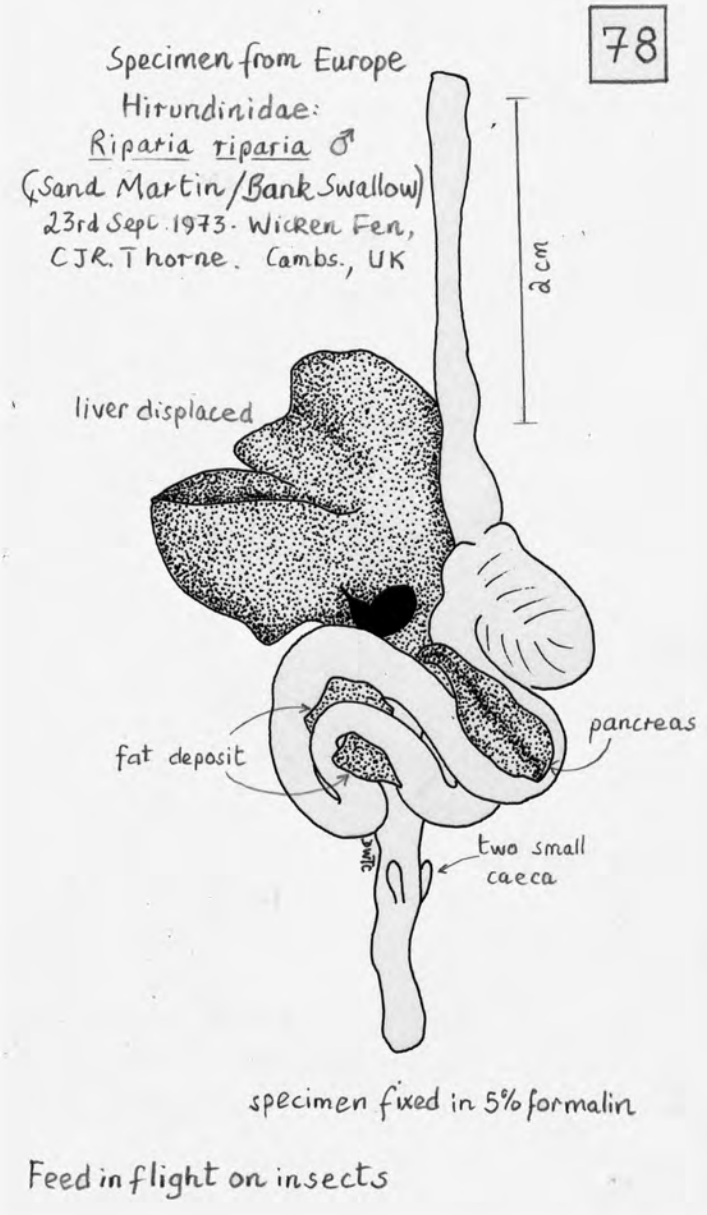
75 *Megarhynchus pitangua* (Boat-billed Flycatcher)



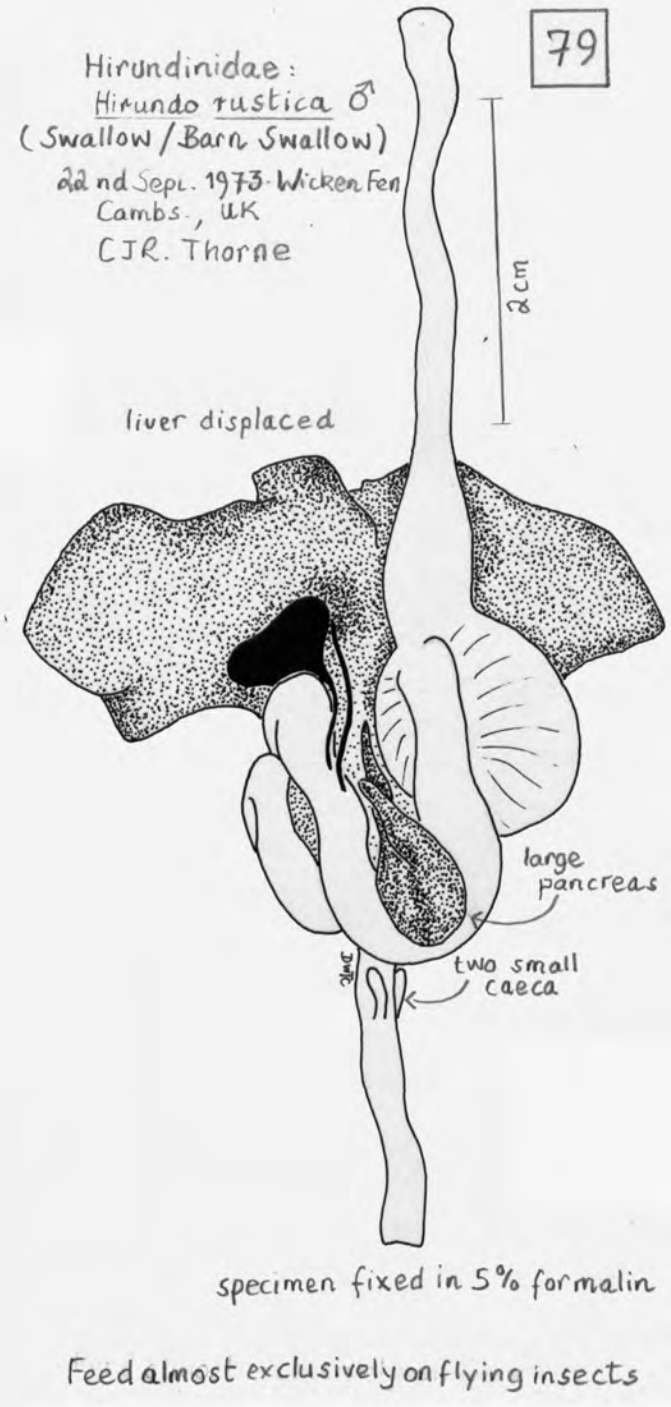
76 *Alauda avensis* (Eurasian Skylark)



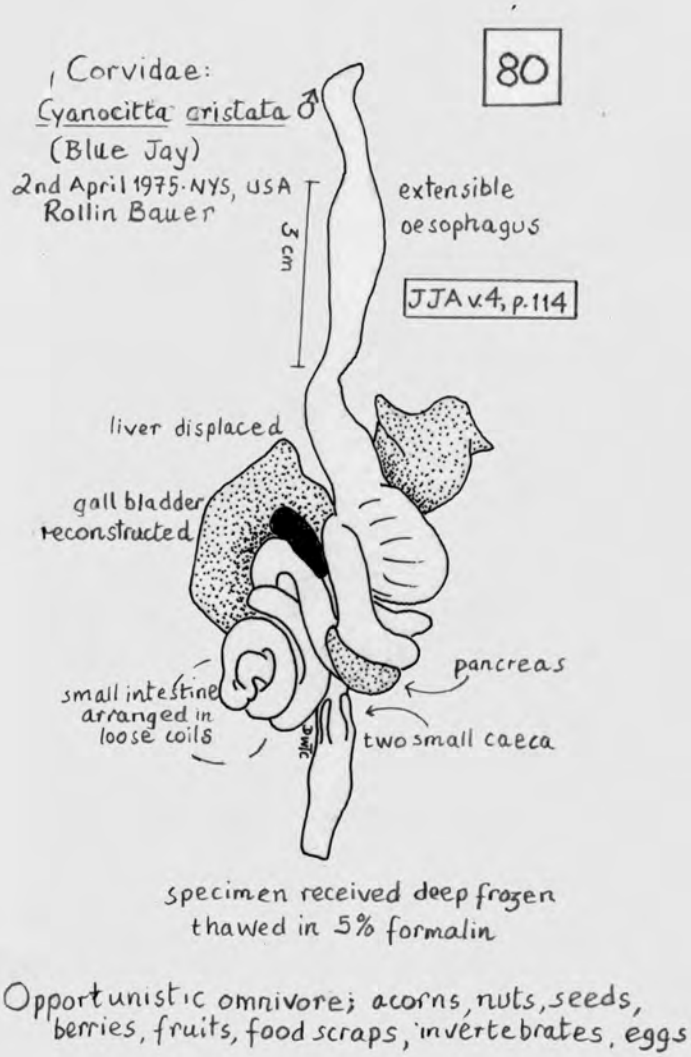
77 *Riparia riparia* (Bank Swallow/Sand Martin)-North America



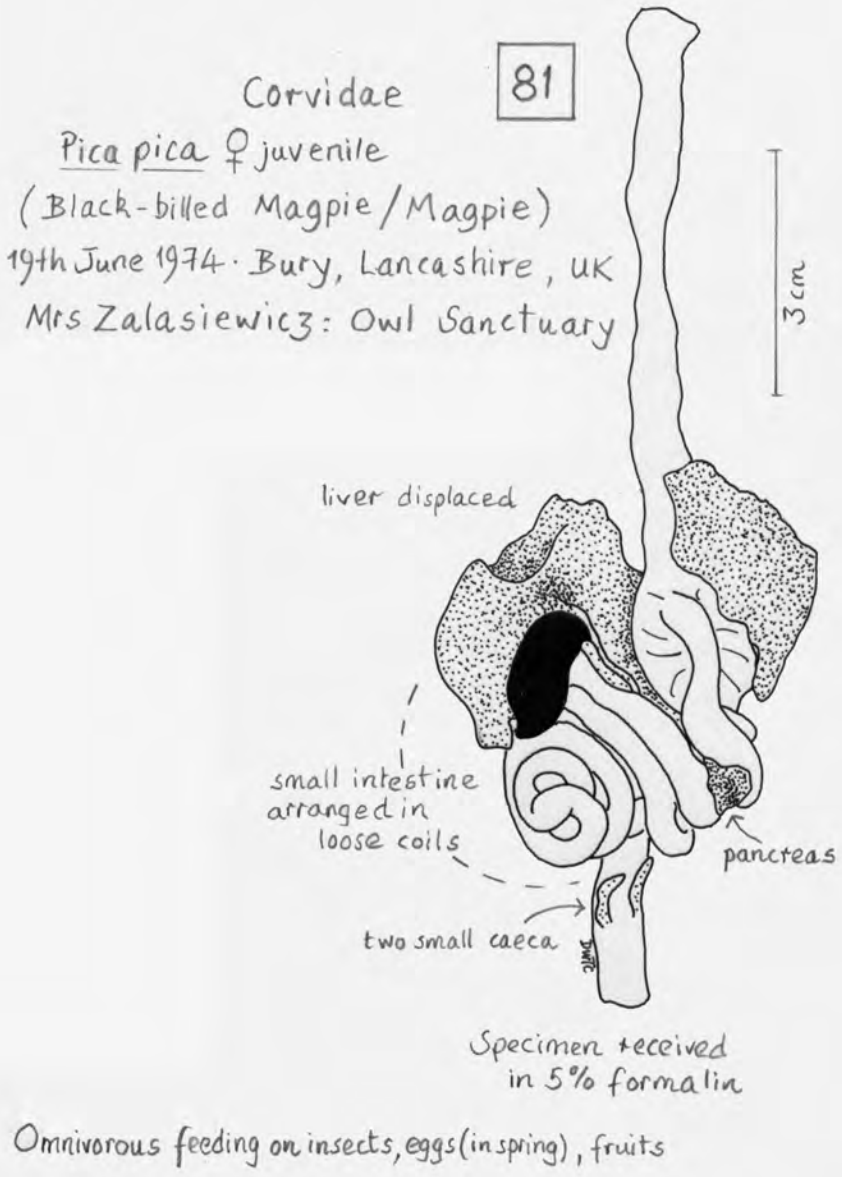
78 *Riparia riparia* (Sand Martin/Bank Swallow)-Europe



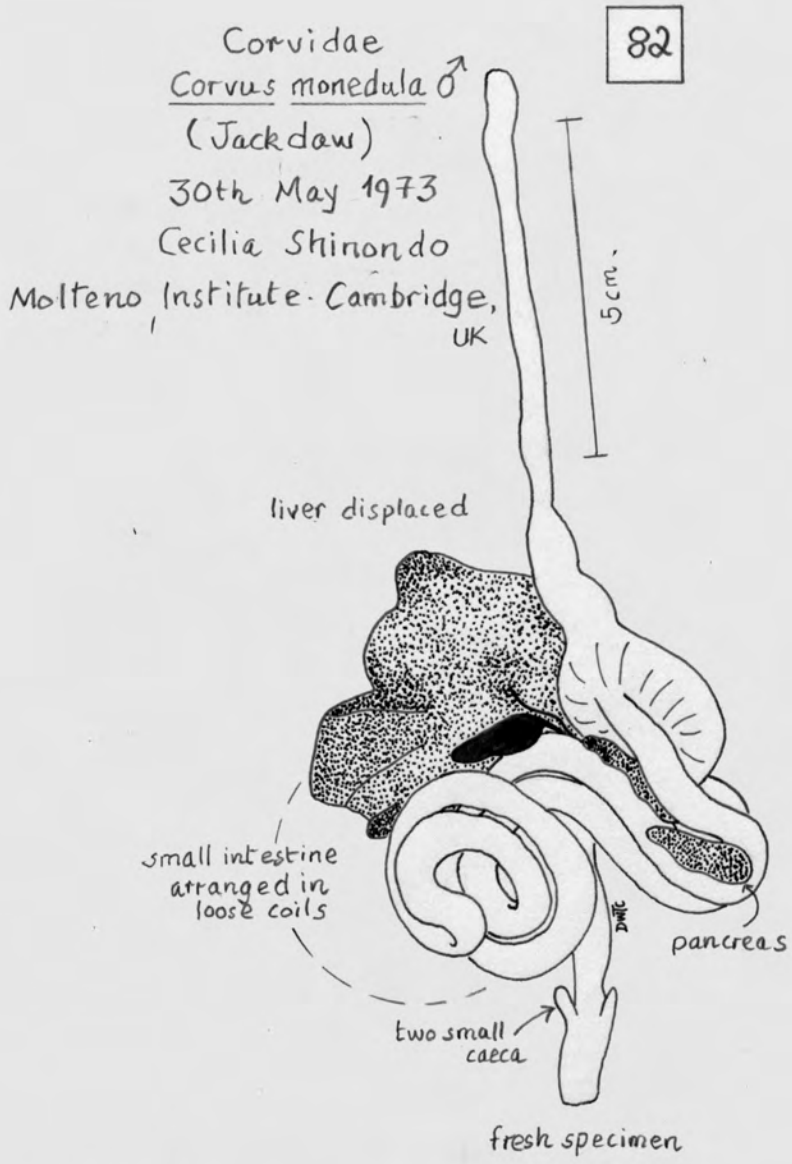
79 *Hirundo rustica* (Swallow/Barn Swallow)



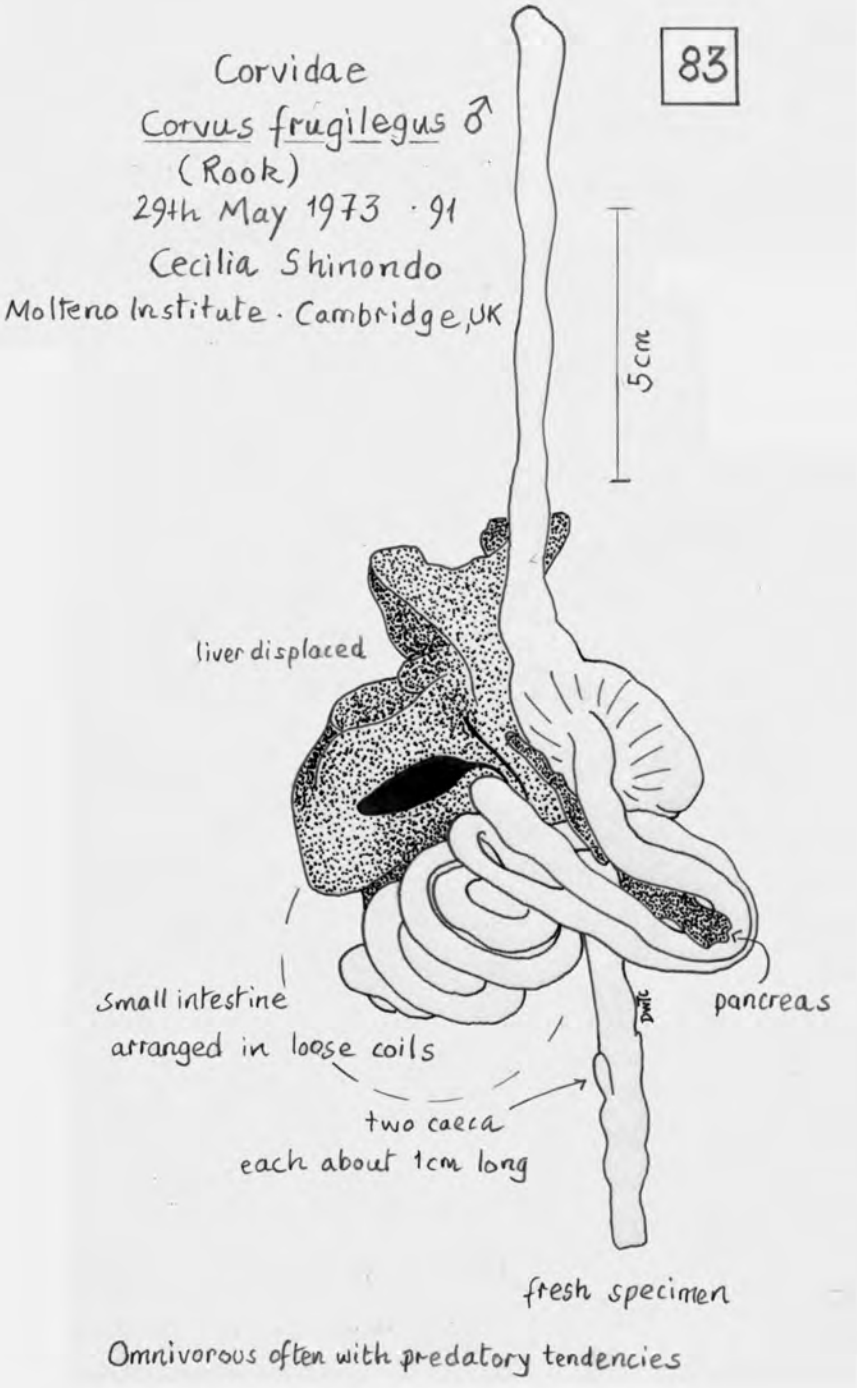
80 *Cyanocitta aristata* (Blue Jay)



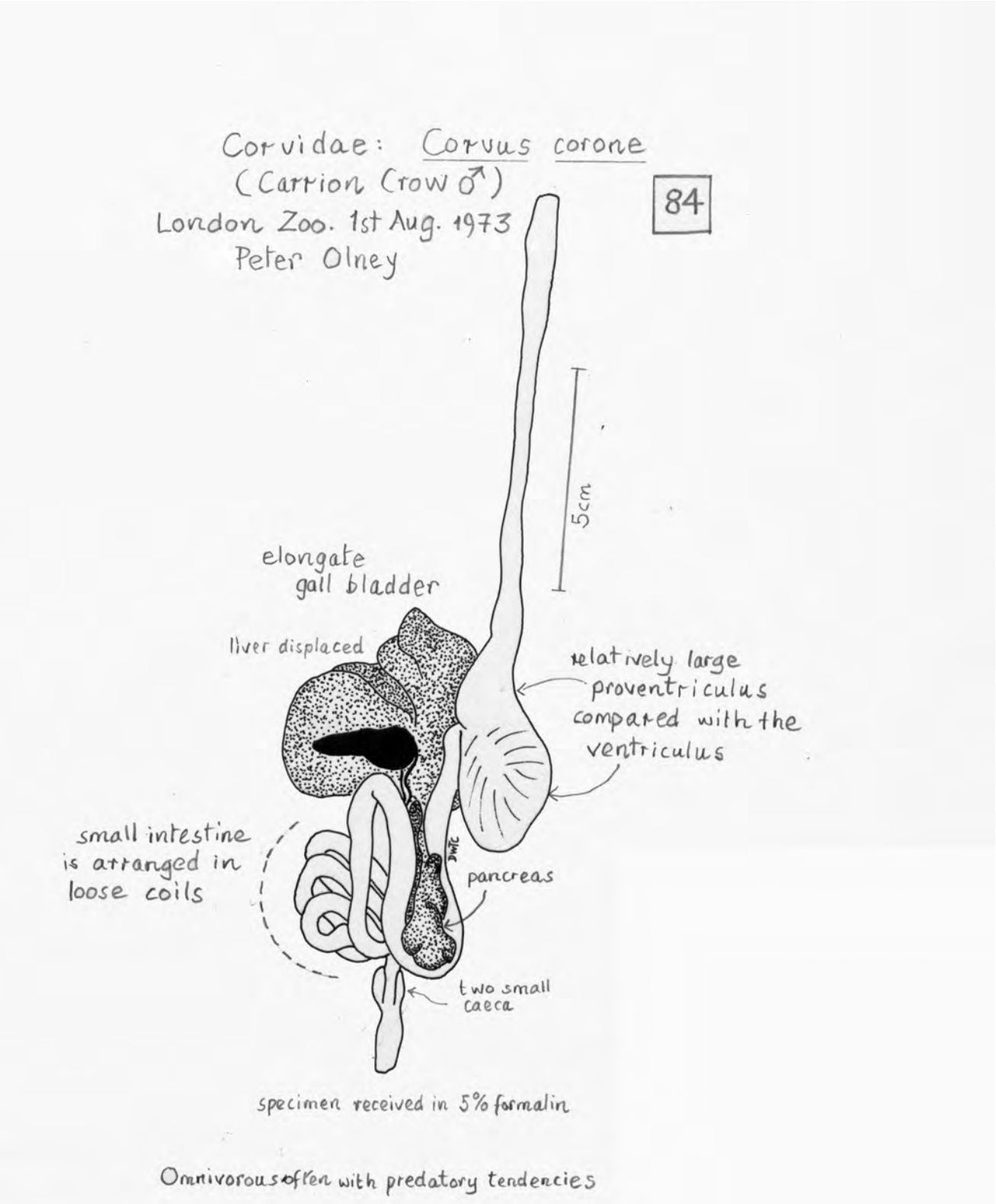
81 *Pica pica* (Black-billed Magpie/Magpie)



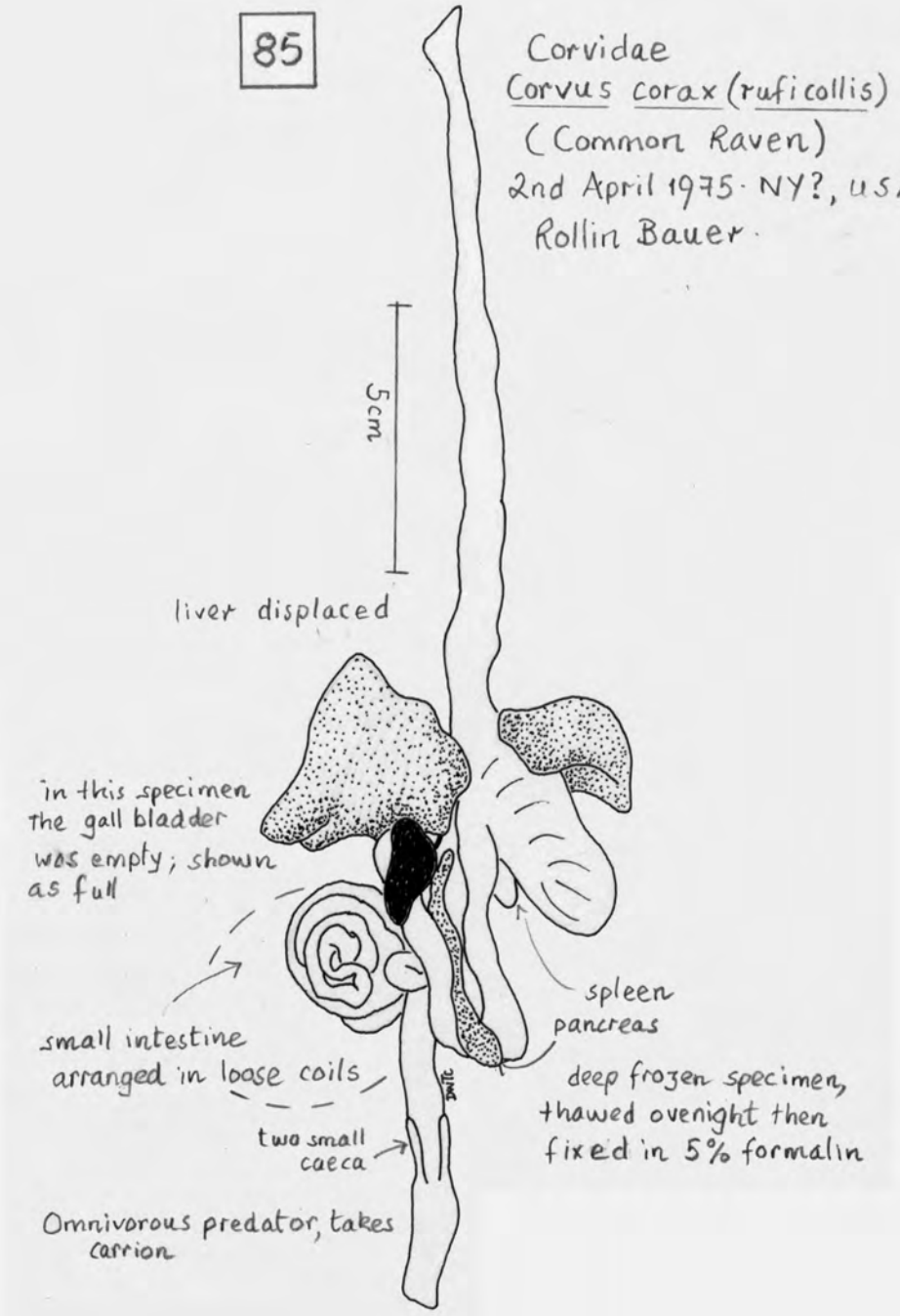
82 *Corvus monedula* (Jackdaw)



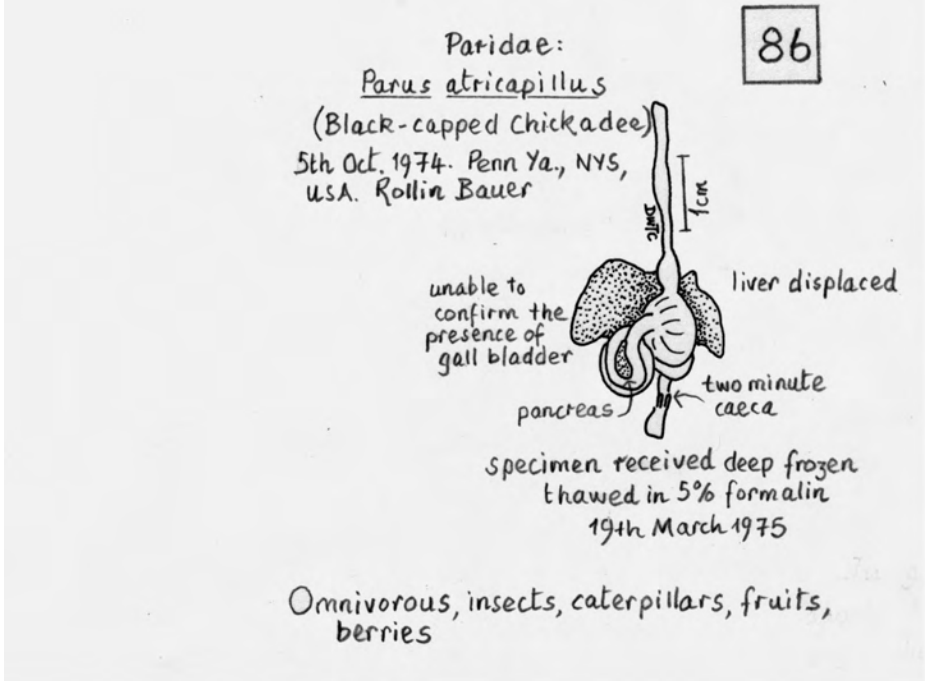
83 *Corvus frugilegus* (Rook)



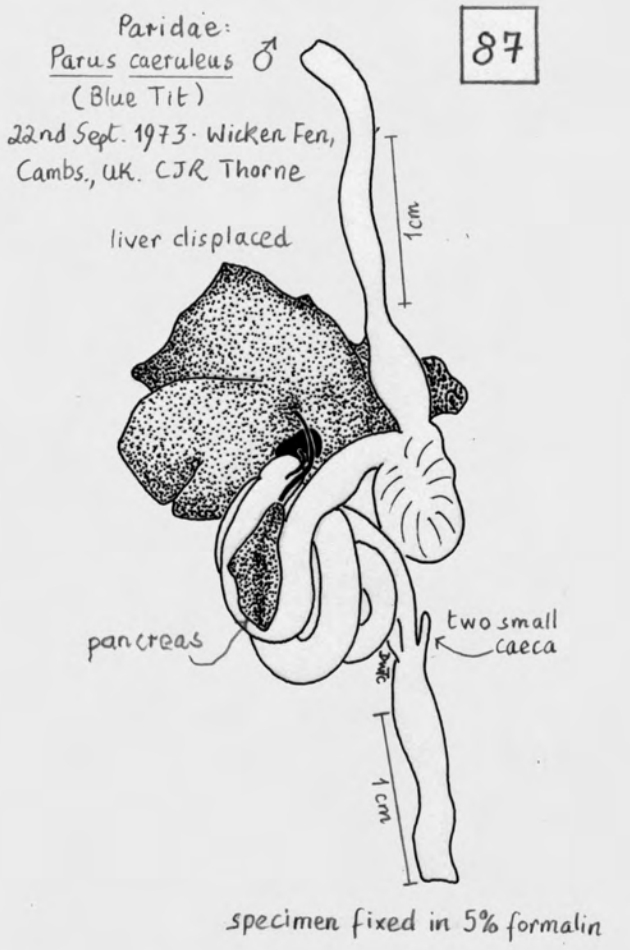
84 *Corvus corone* (Carrion Crow)



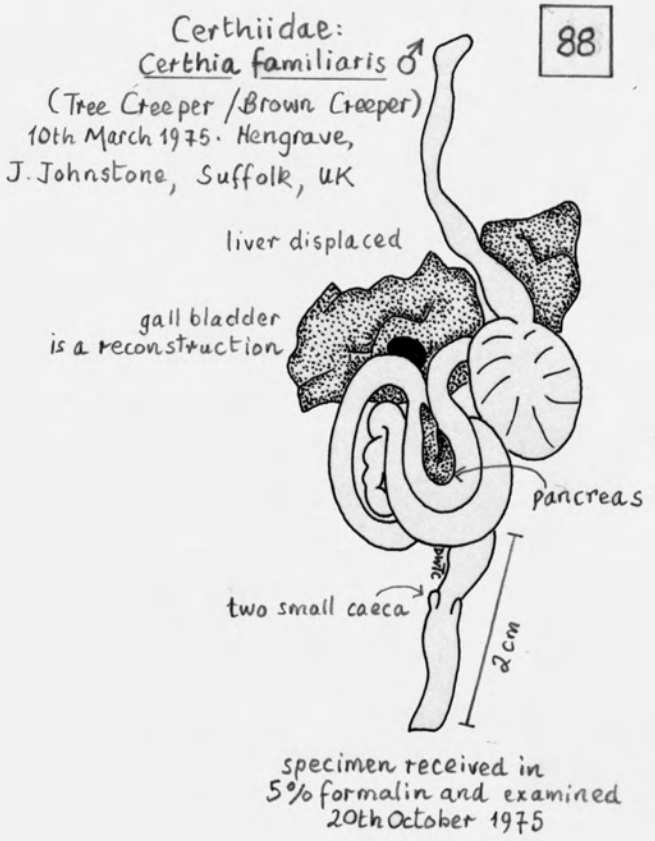
85 *Corvus corax (ruficollis)* (Common Raven)



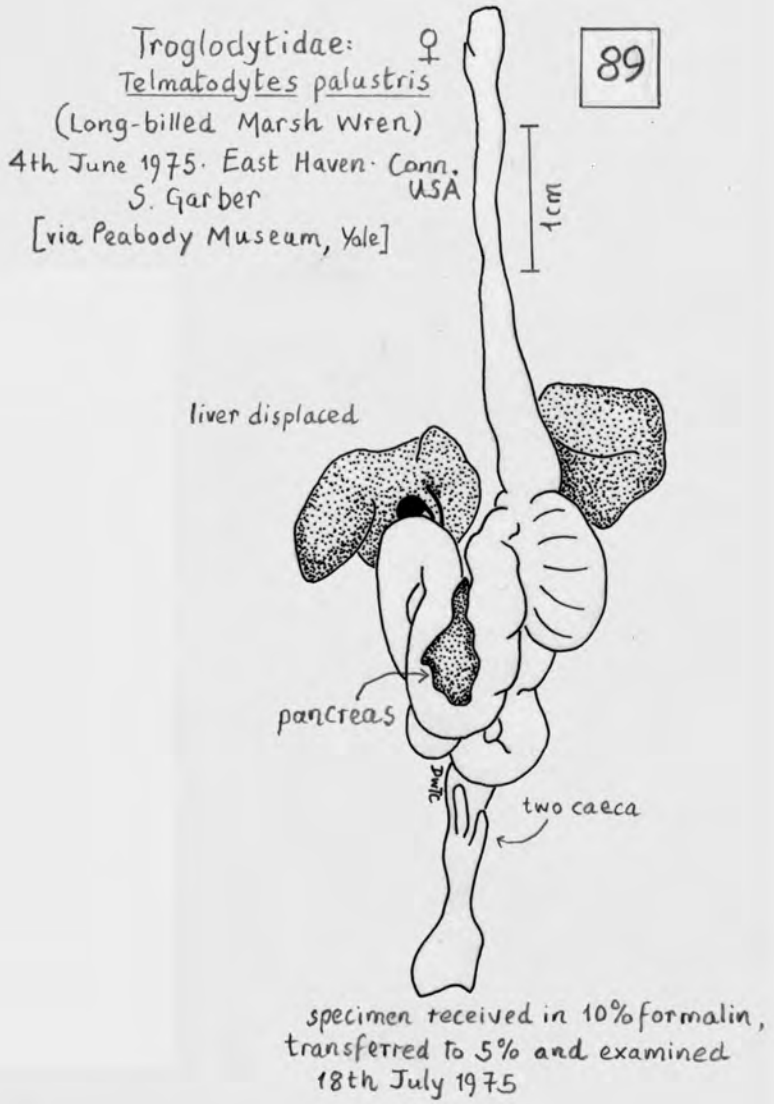
86 *Parus atricapillus* (Black-capped Chickadee)



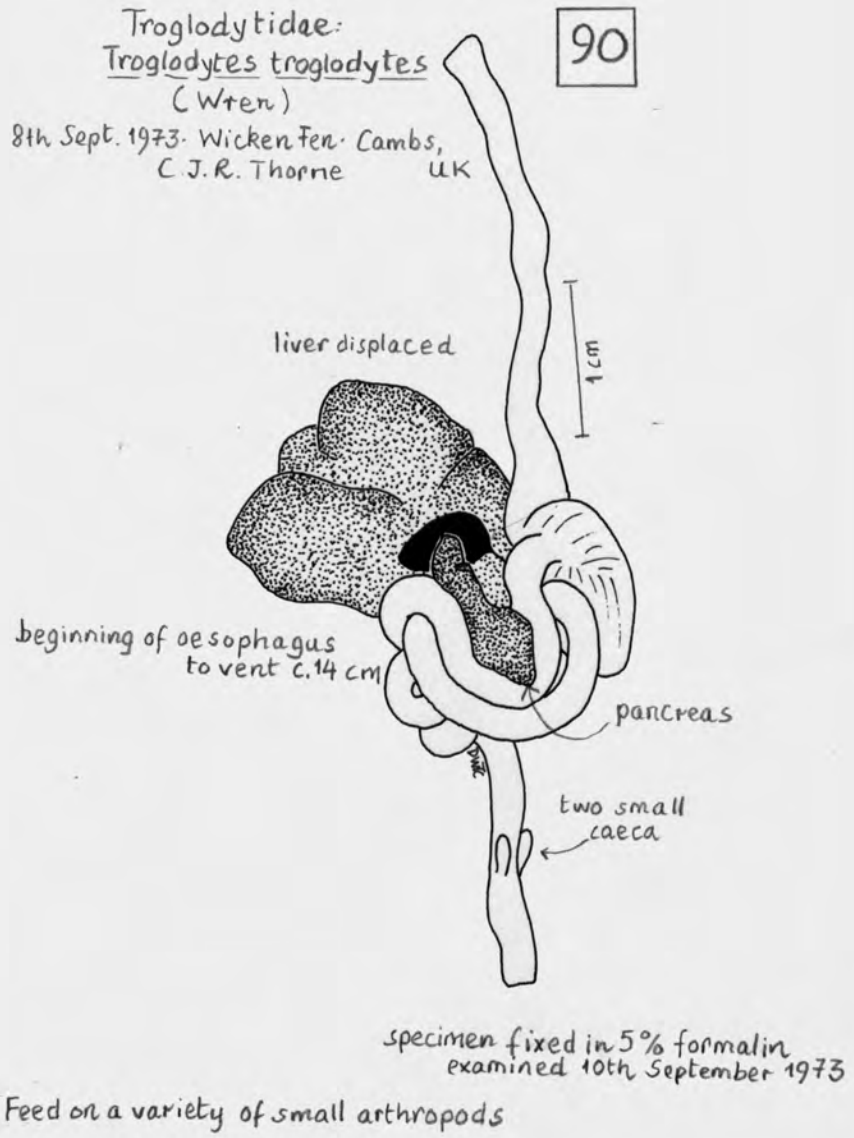
87 *Parus caeruleus* (Blue Tit)



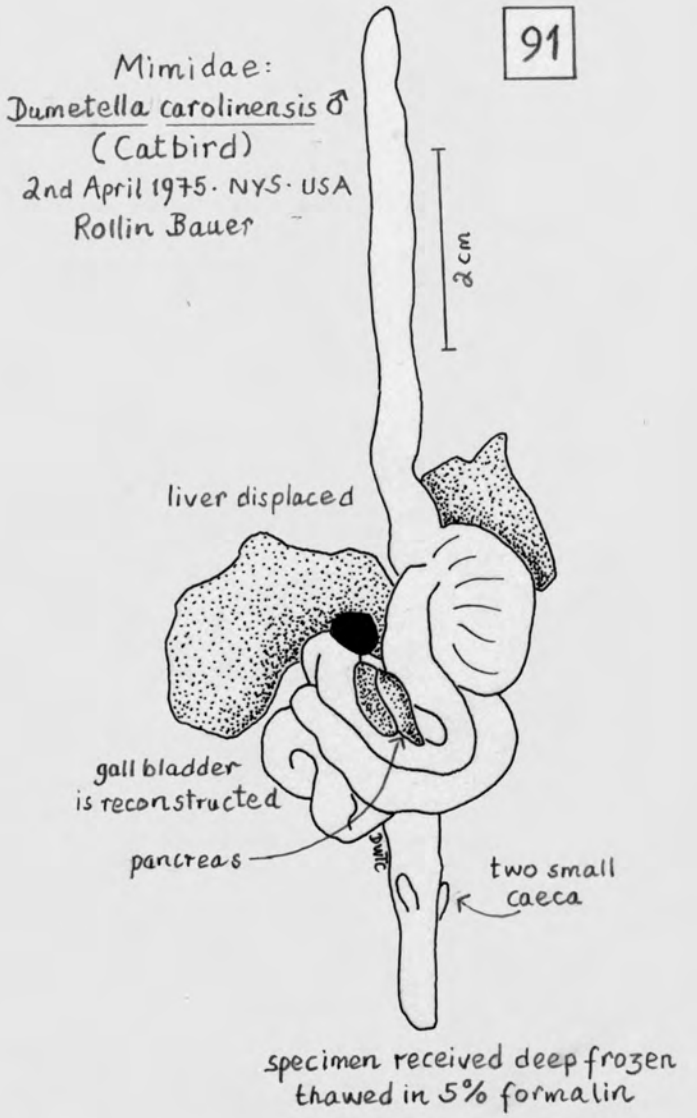
88 *Certhia familiaris* (Tree Creeper/Brown Creeper)



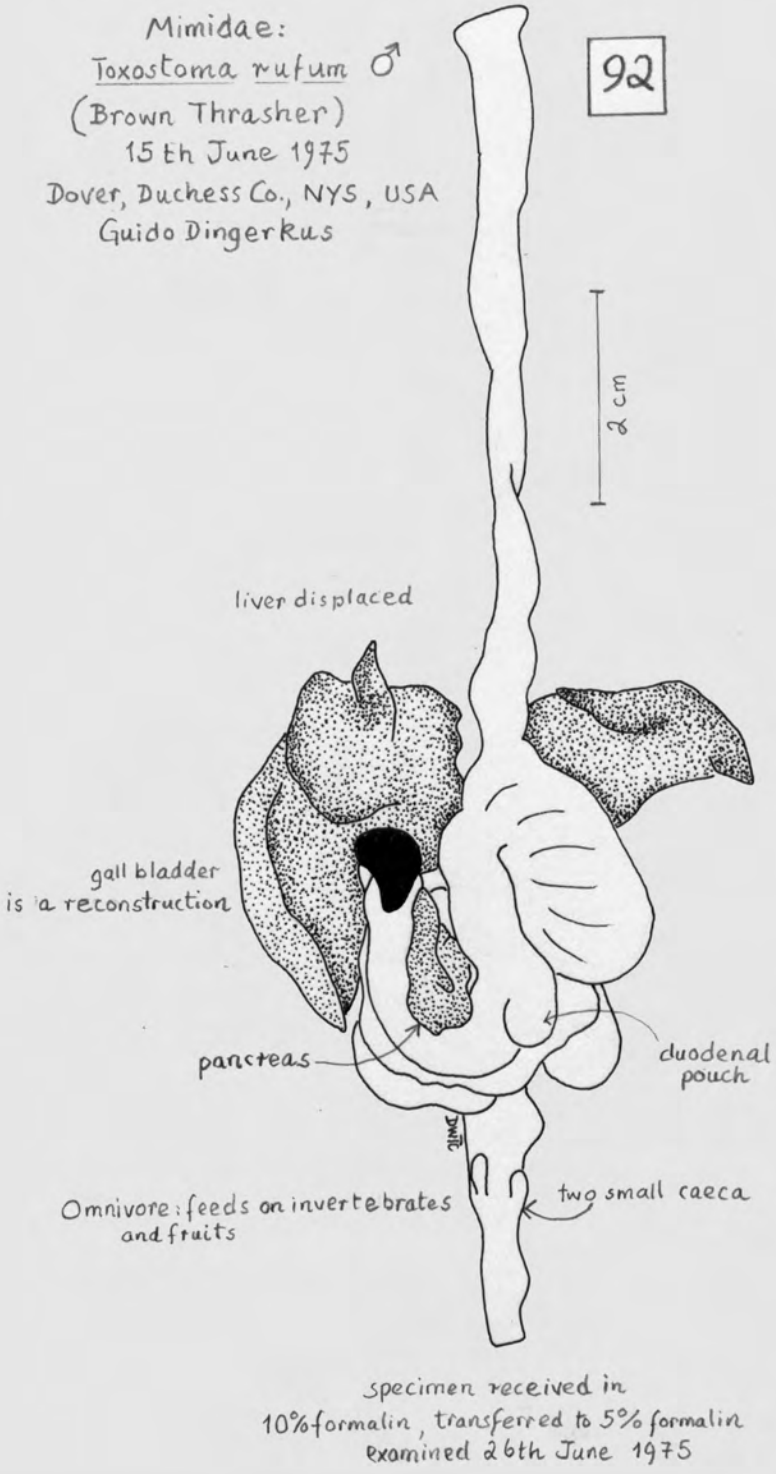
89 *Telmatodytes palustris* (Long-billed Marsh Wren)



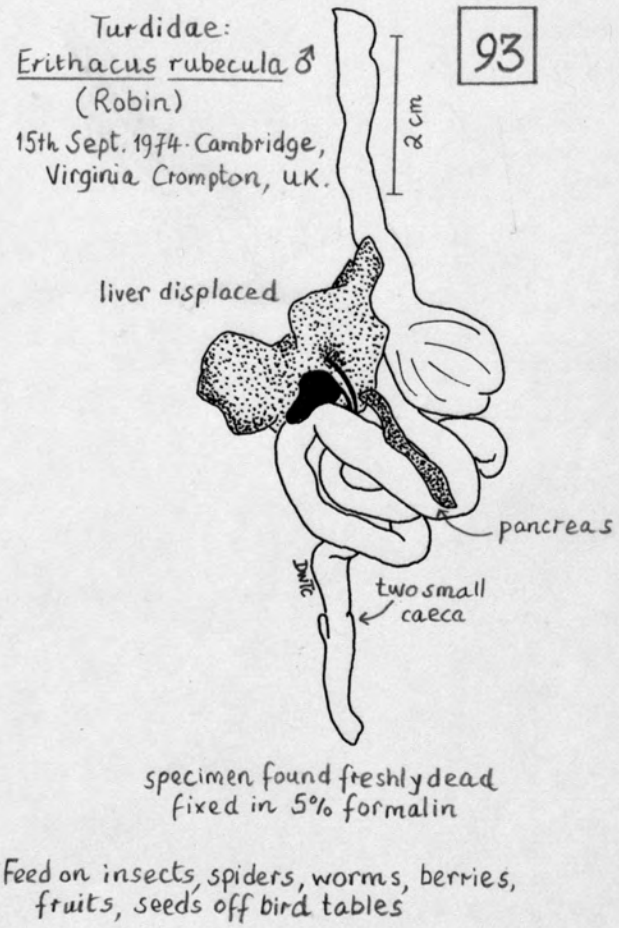
90 *Troglodytes troglodytes* (Wren)



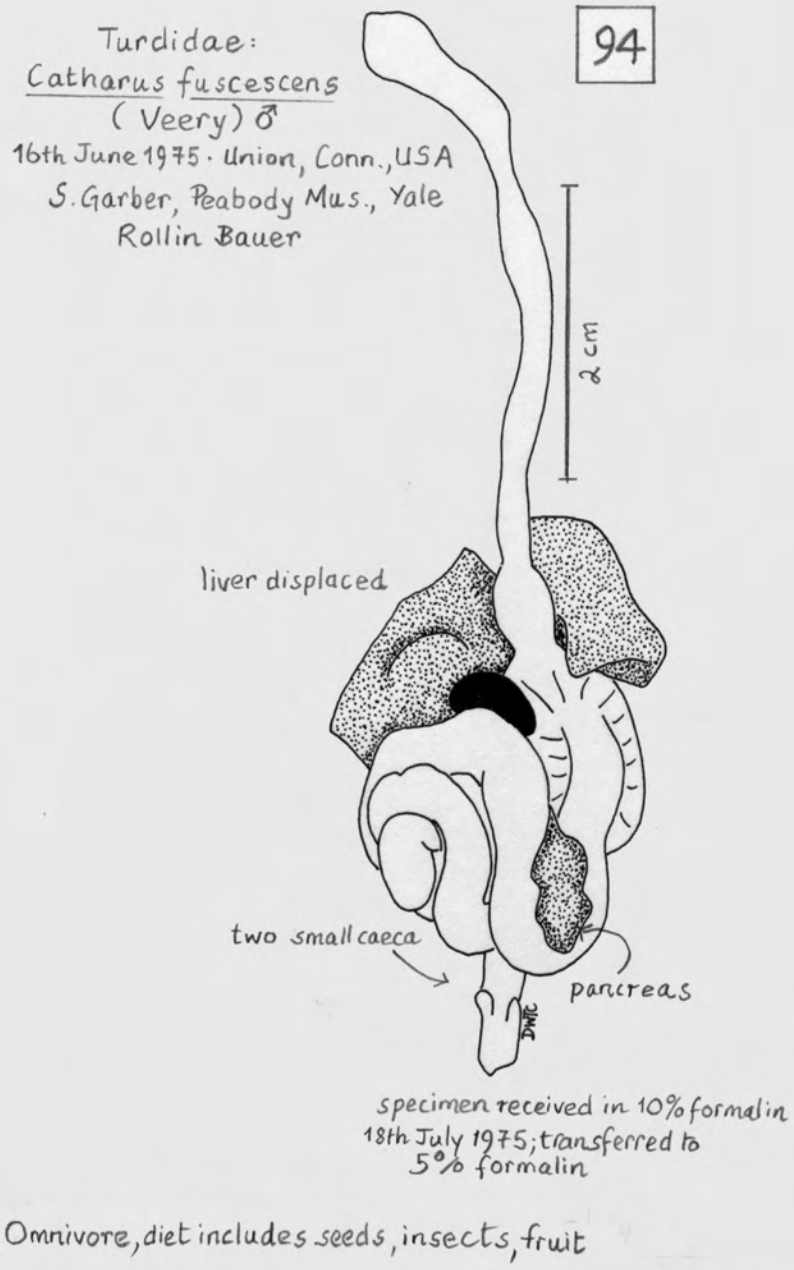
91 *Dumetella carolinensis* (Catbird)



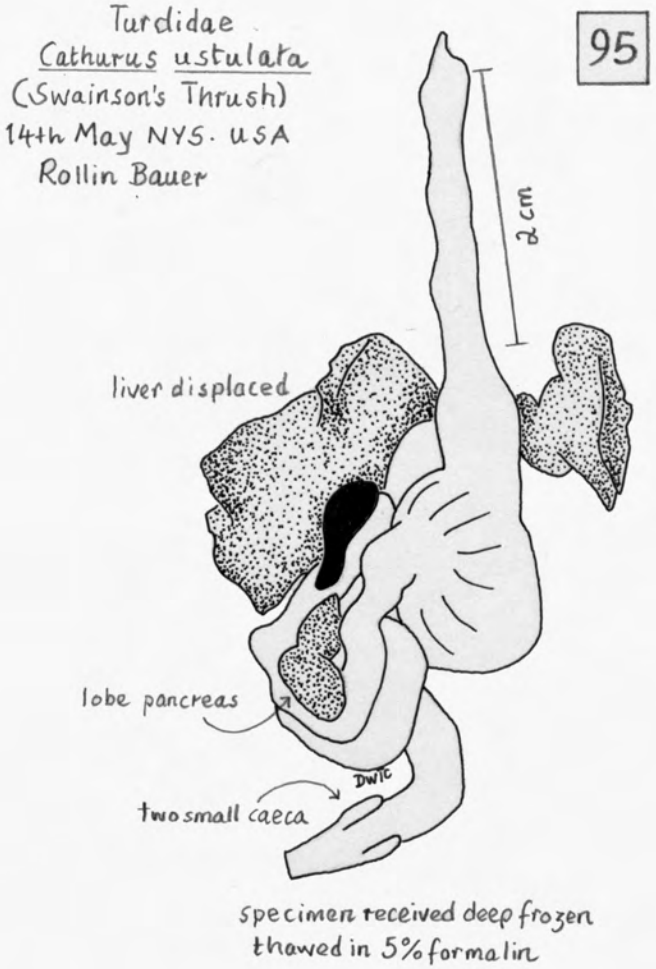
92 *Toxostoma rufum* (Brown Thrasher)



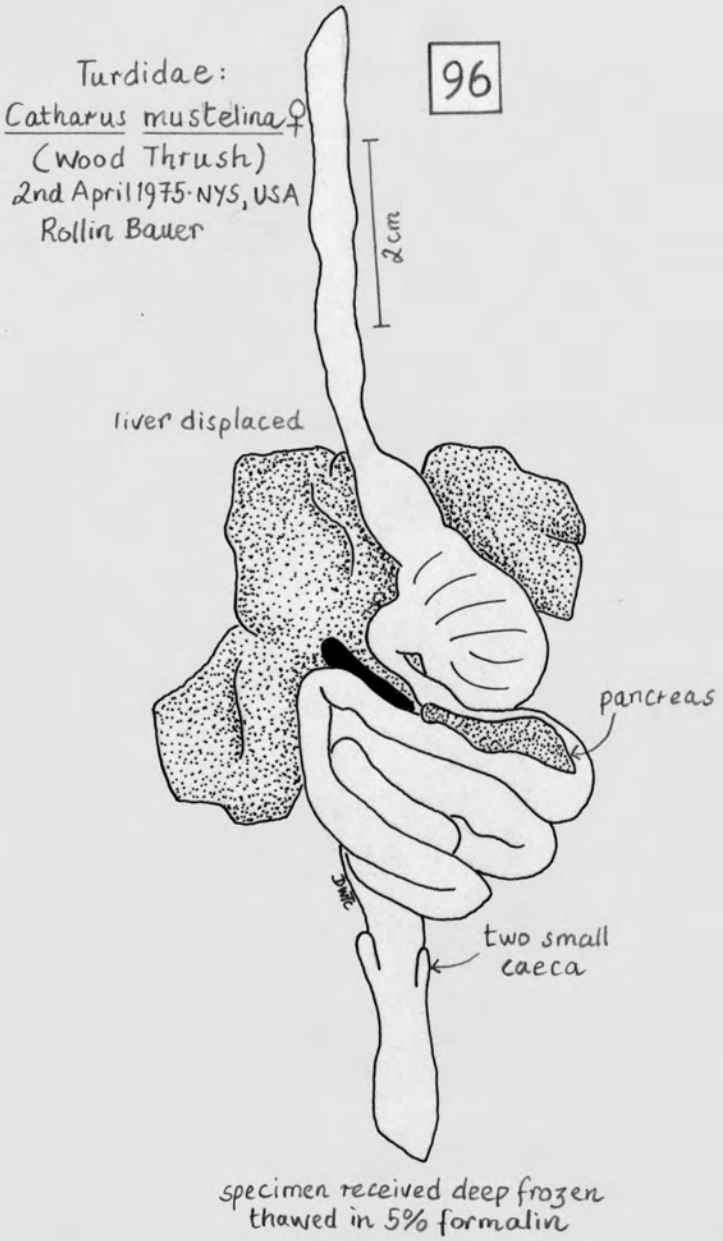
93 *Erithacus rubecula* (Robin)



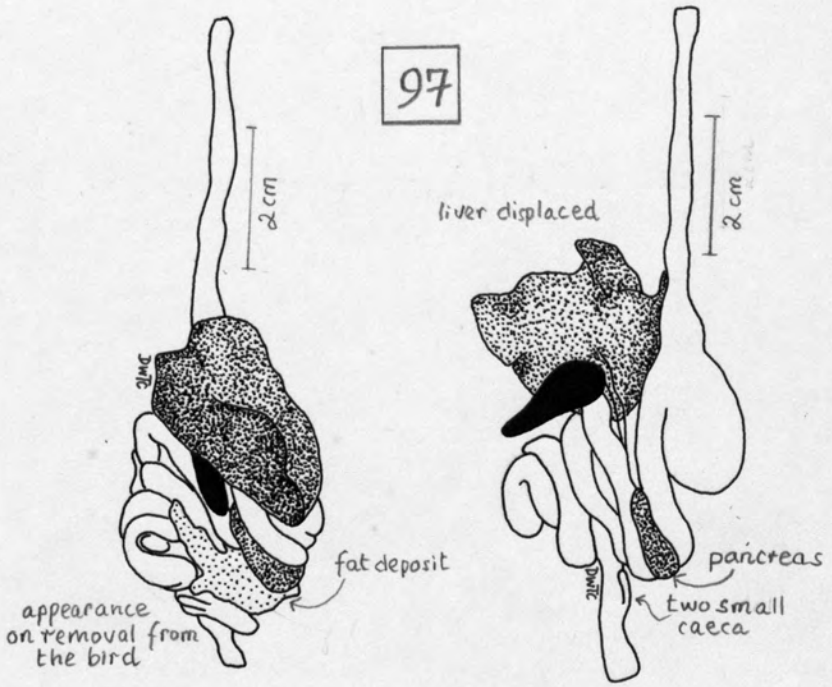
94 *Catharus fuscescens* (Veery)



95 *Catharus ustulata* (Swainson's Thrush)



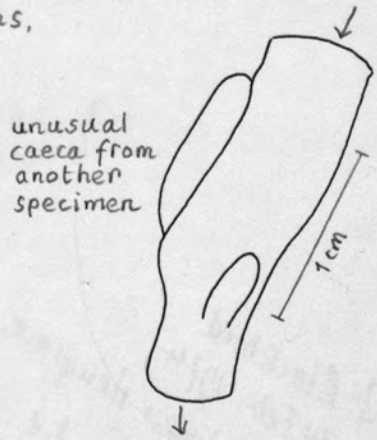
96 *Catharus mustelina* (Wood Thrush)



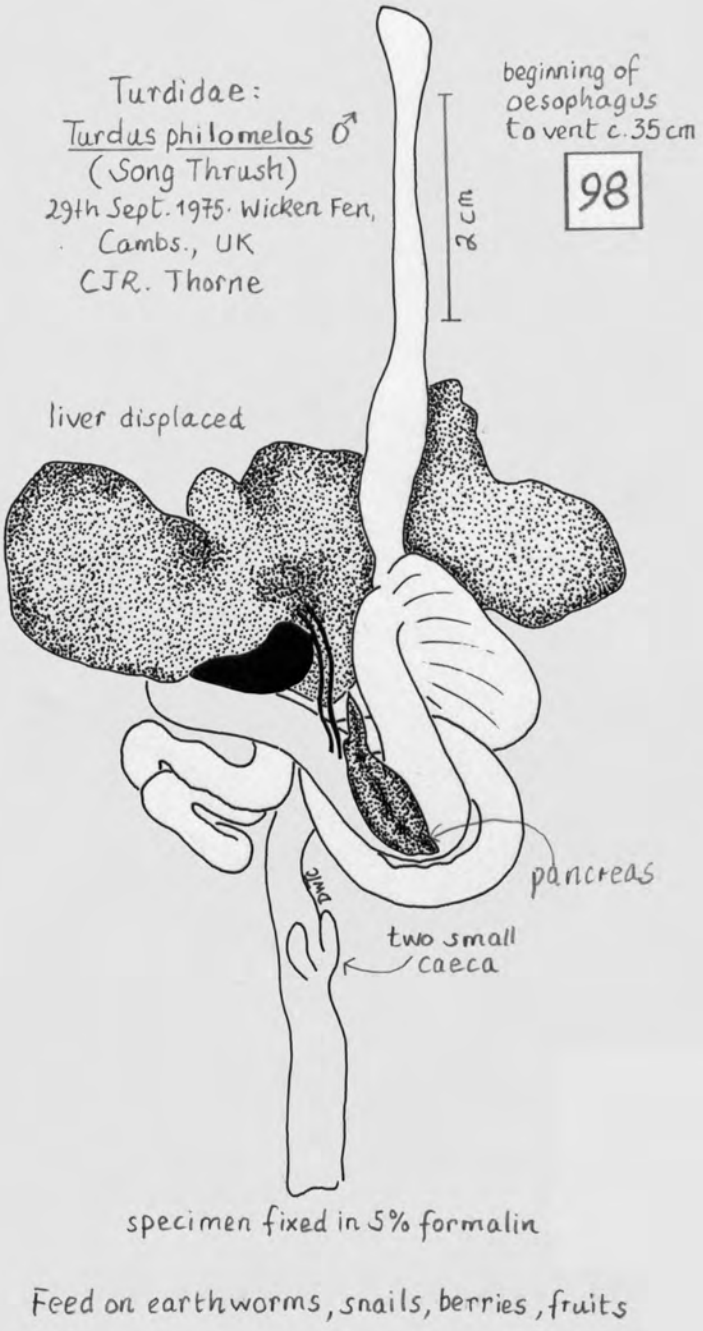
Turdidae:
Turdus merula ♀
(Blackbird)
14th February 1974 · Hengrave, Suffolk, UK
J. Johnstone

specimens received in 5% formalin

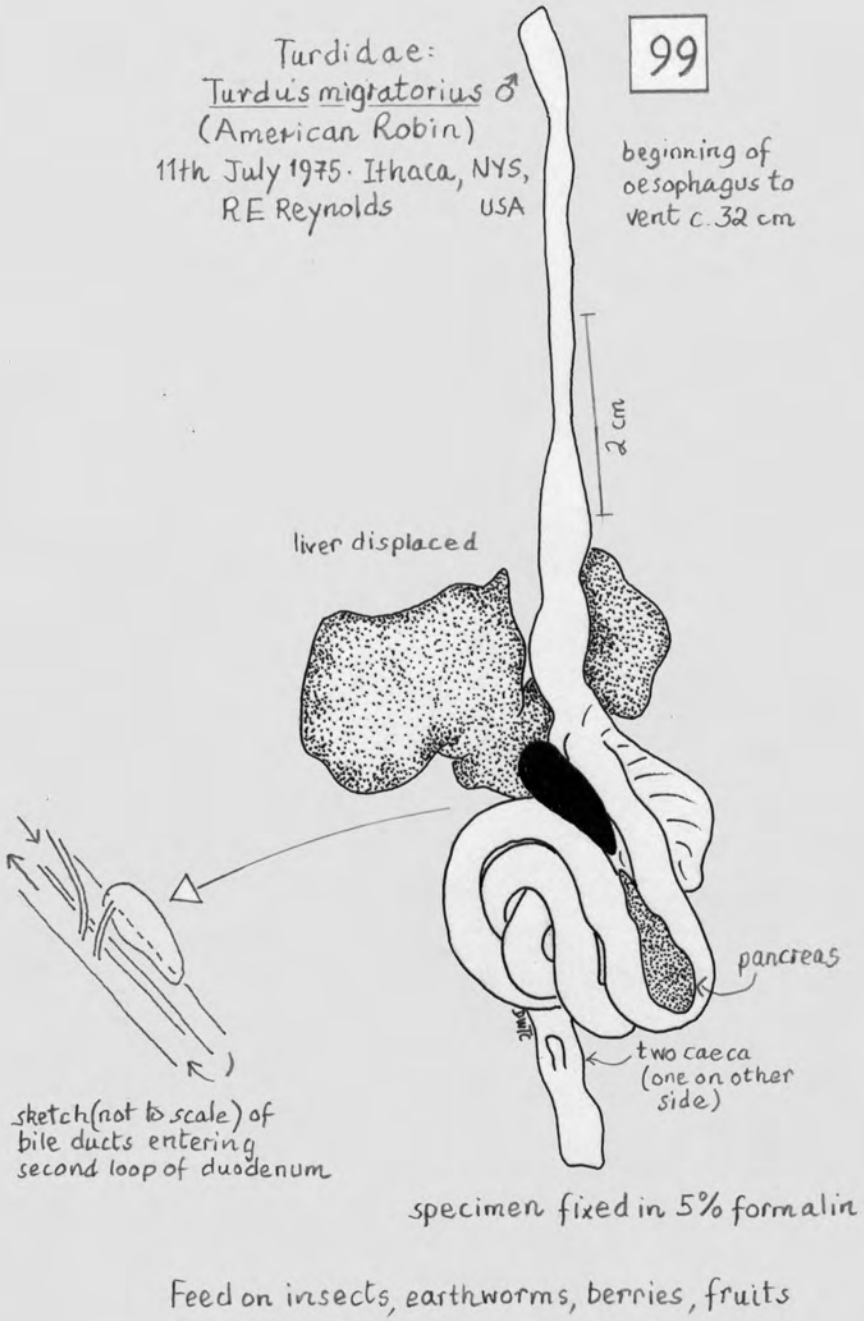
Omnivore: diet includes earthworms, invertebrates, fruits



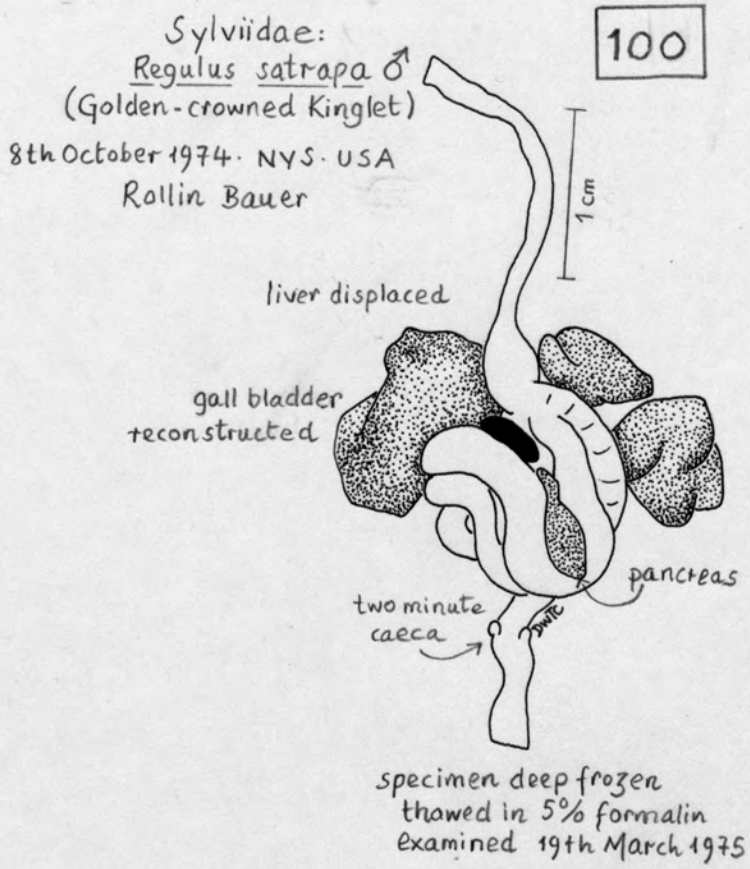
97 *Turdus merula* (Blackbird)



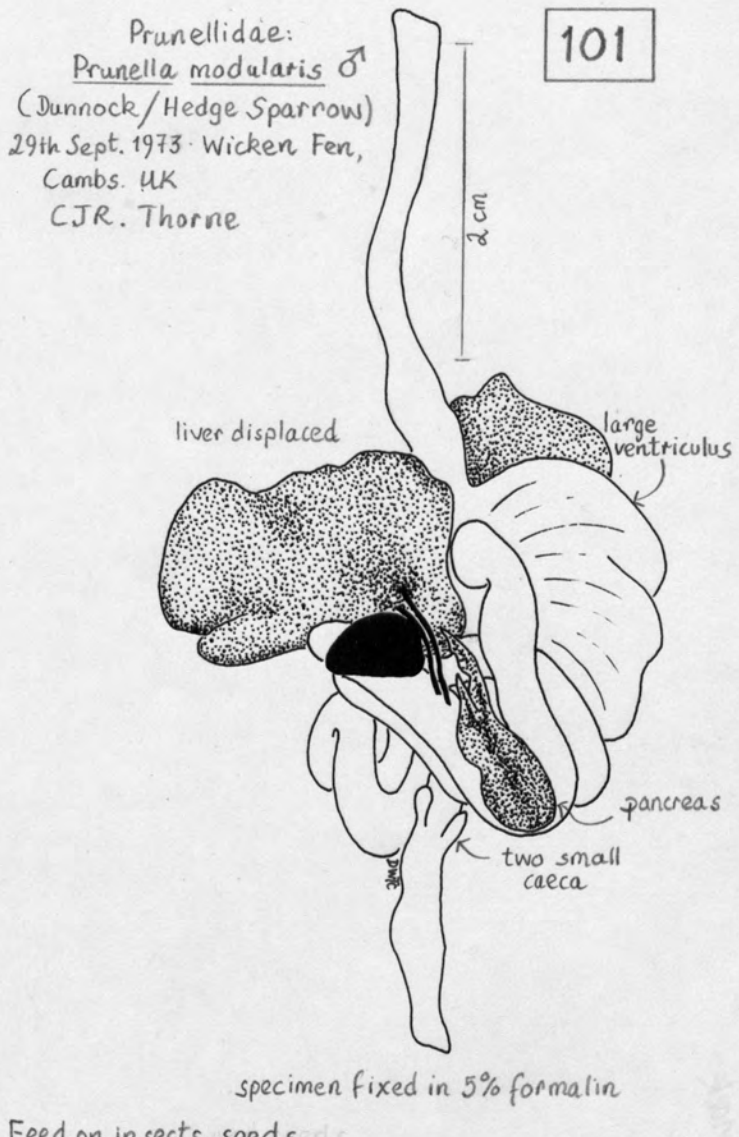
98 *Turdus philomelos* (Song Thrush)



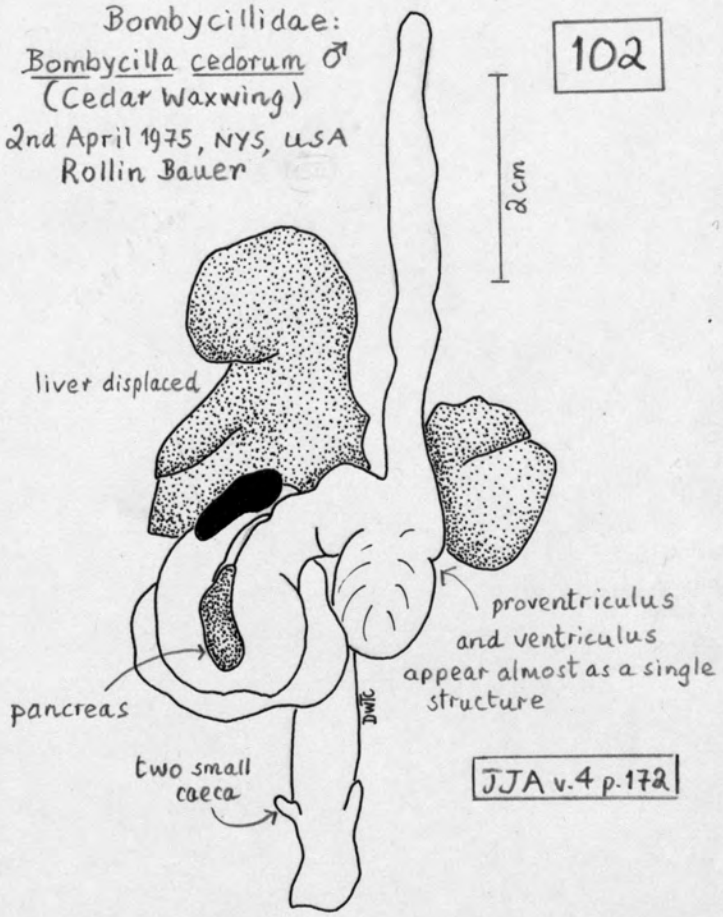
99 *Turdus migratorius* (American Robin)



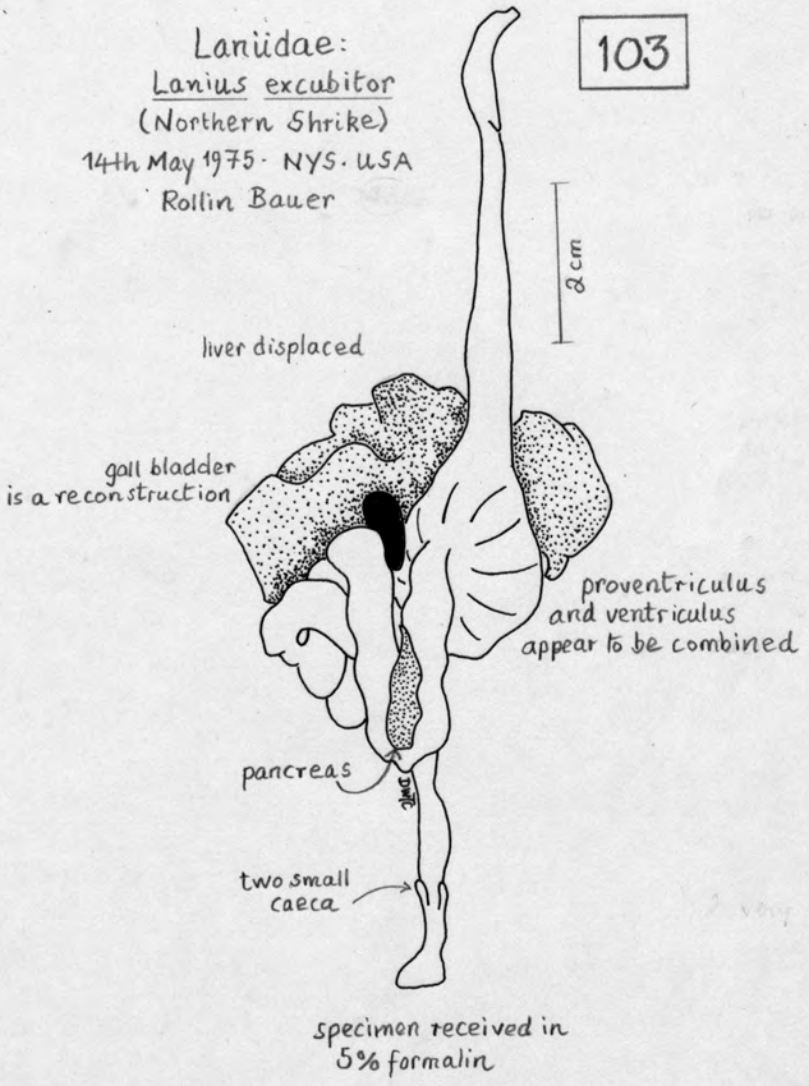
100 *Regulus satrapa* (Golden-crowned Kinglet)



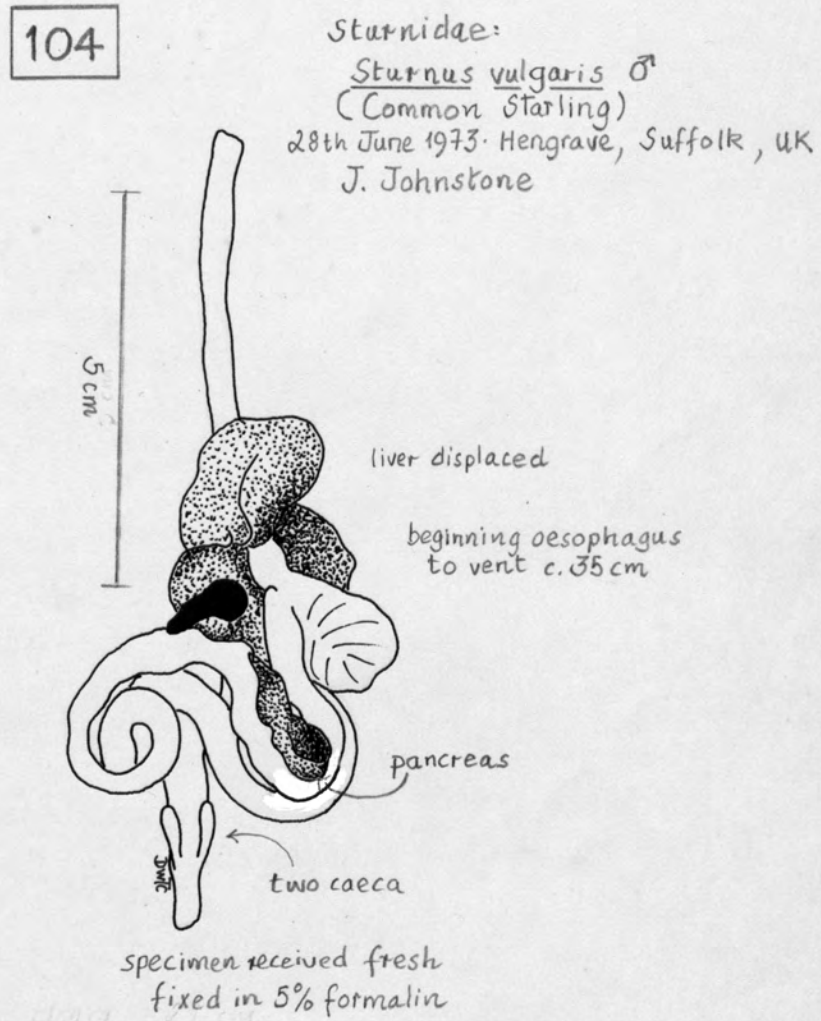
101 *Prunella modularis* (Dunnock/Hedge Sparrow)



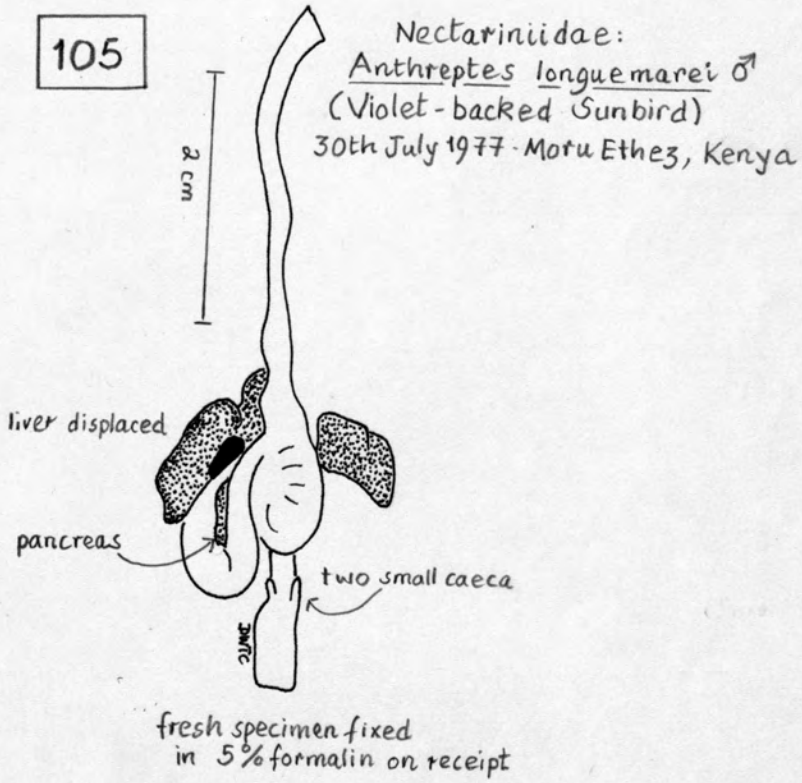
102 *Bombycilla cedorum* (Cedar Waxwing)



103 *Lanius excubitor* (Northern Shrike)

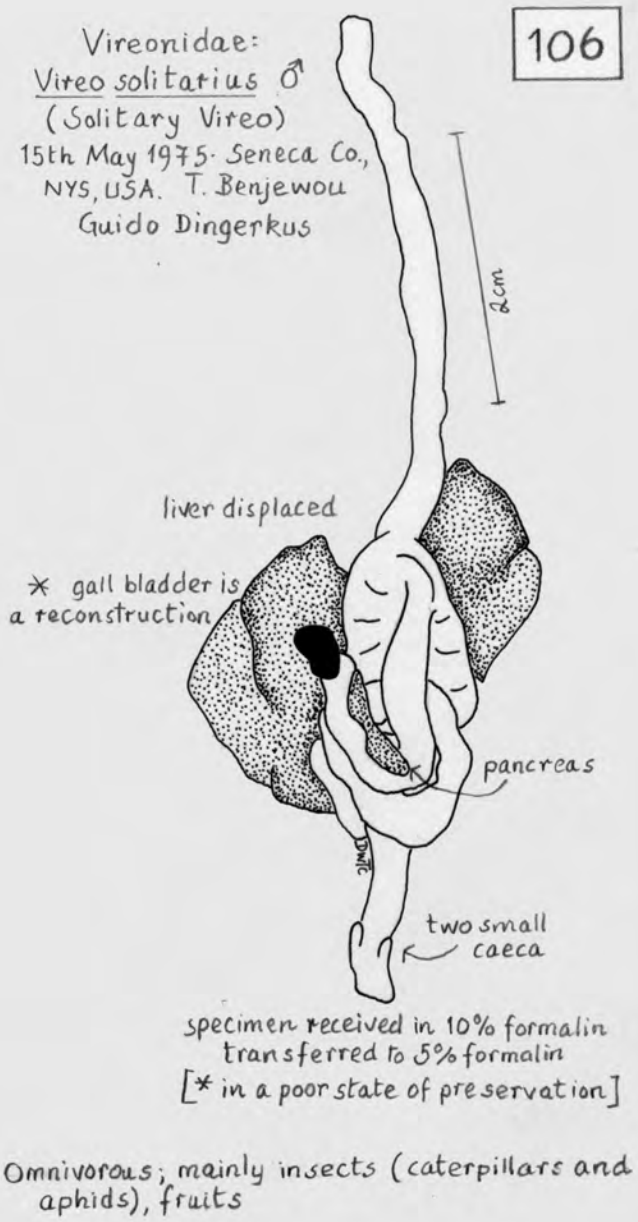


104 *Sturnus vulgaris* (Common Starling)

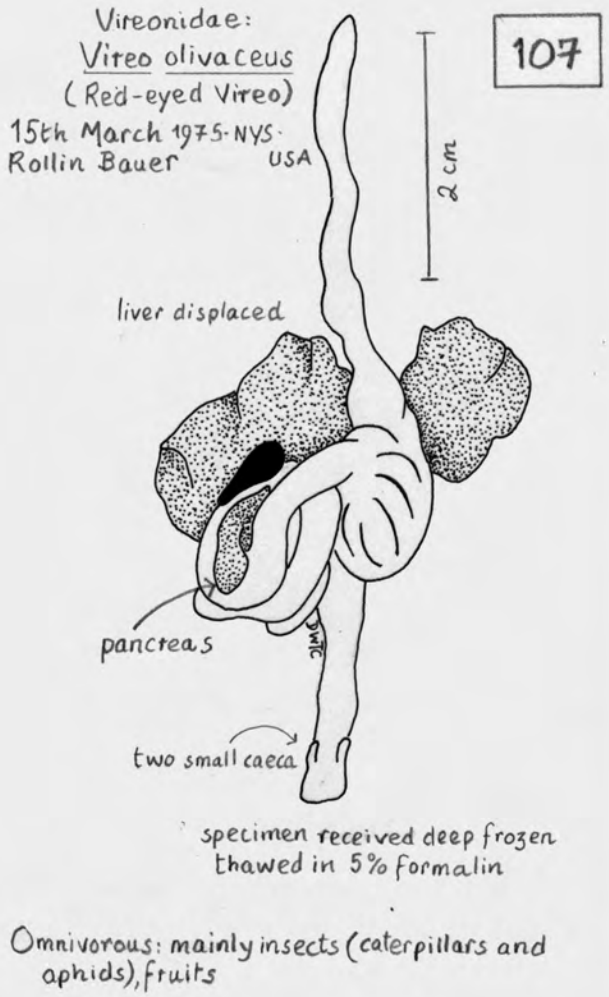


Feed mainly on nectar, but also take insects and spiders

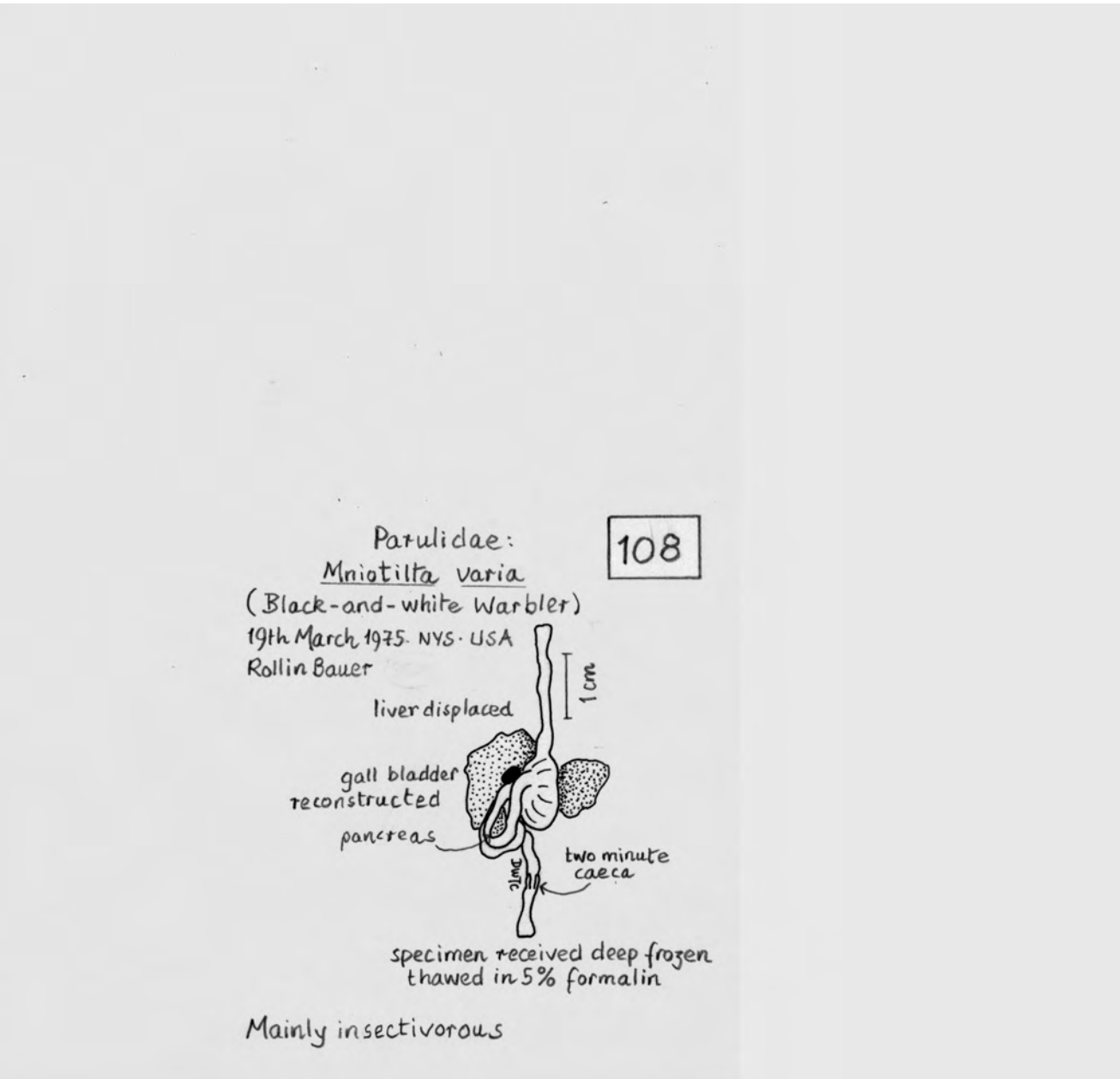
105 *Anthreptes longuemarei* (Violet-backed Sunbird)



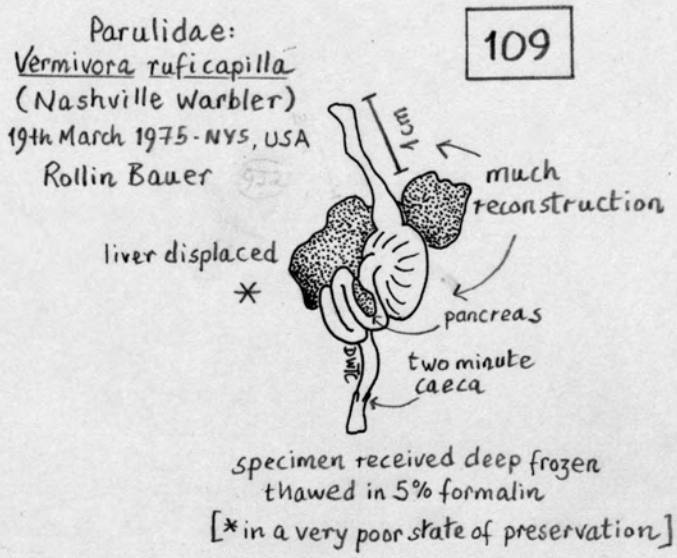
106 *Vireo solitarius* (Solitary Vireo)



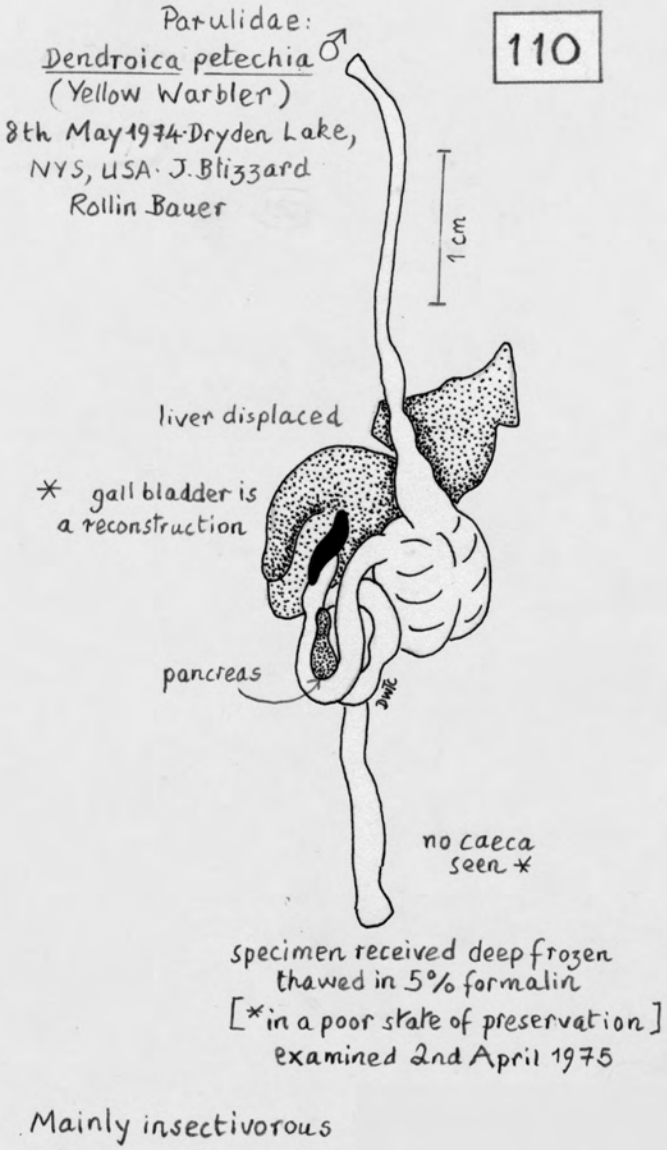
107 *Vireo olivaceus* (Red-eyed Vireo)



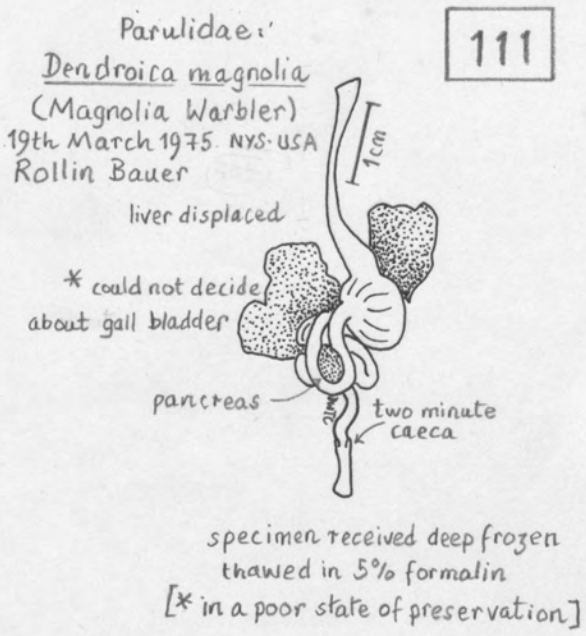
108 *Mniotilta varia* (Black-and White Warbler)



109 *Vermivora ruficapilla* (Nashville Warbler)

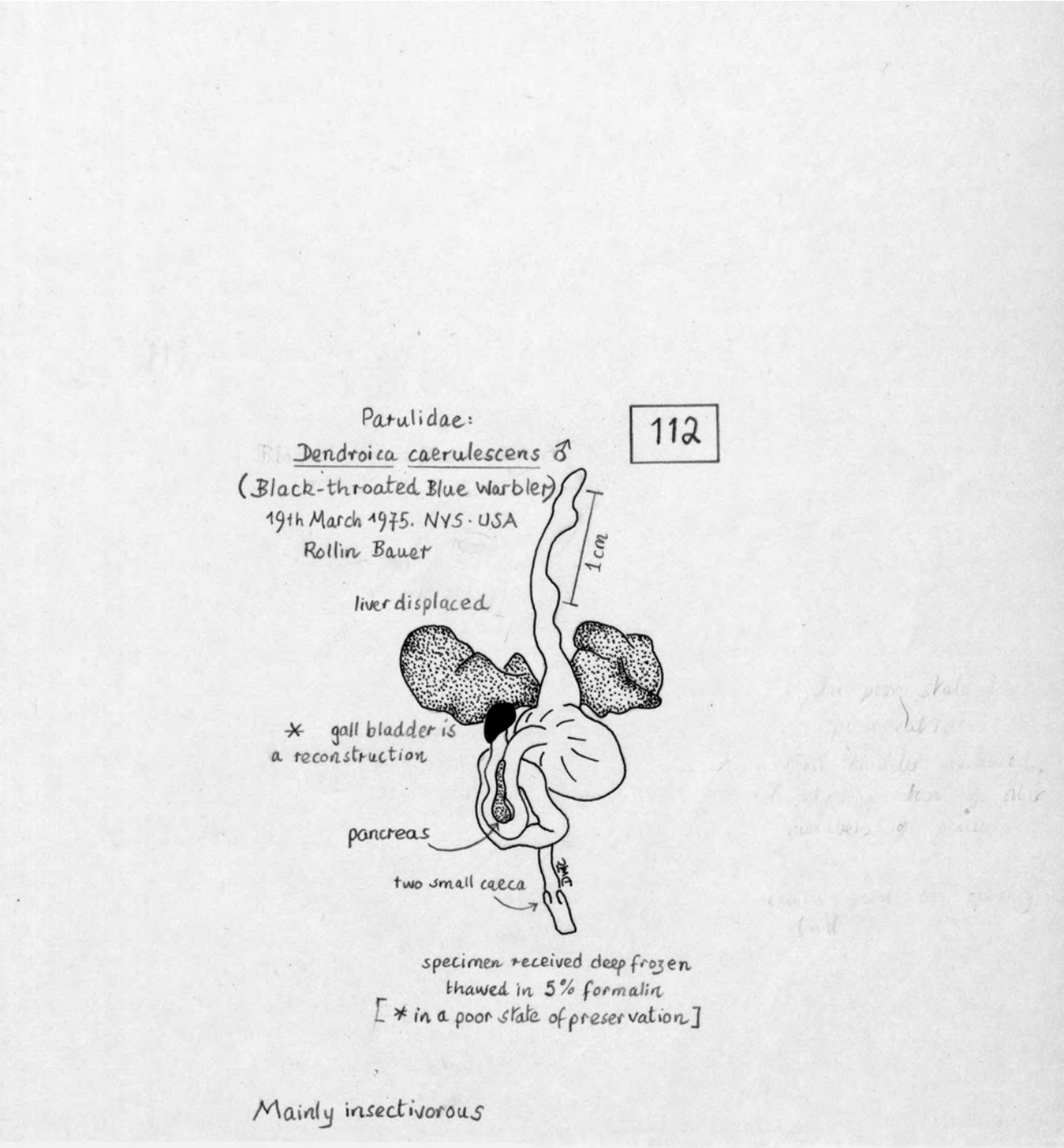


110 *Dendroica petechia* (Yellow Warbler)

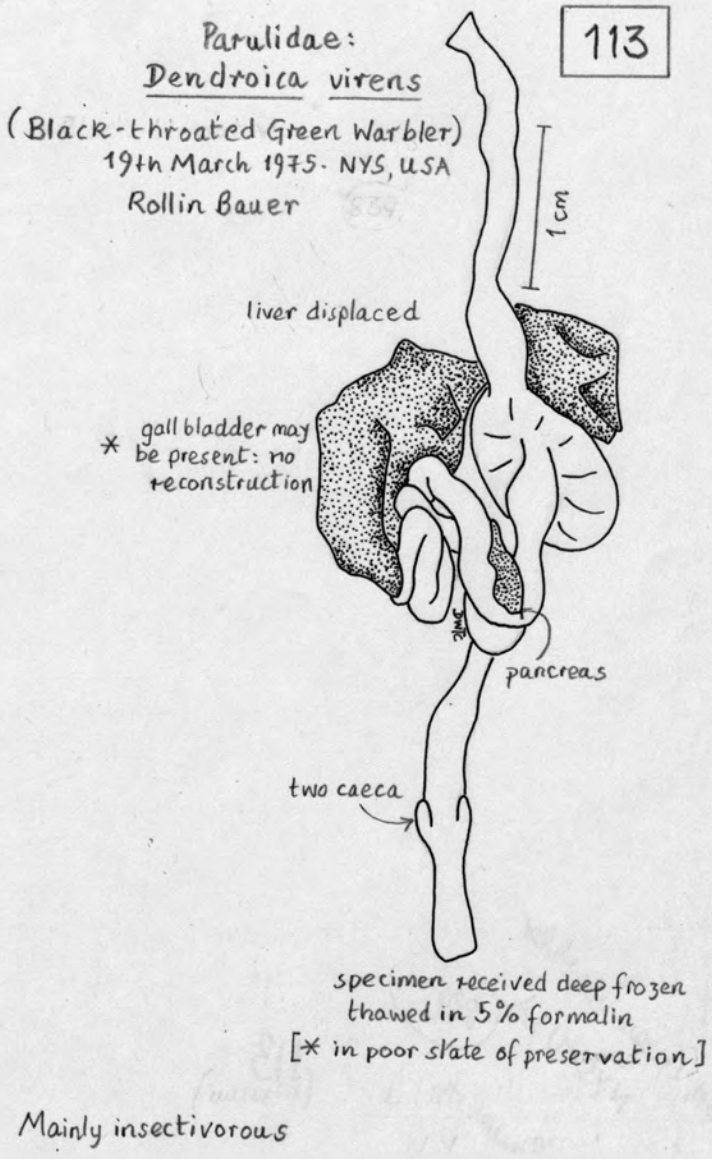


Feeds mainly on insects - also takes fruits, nectar

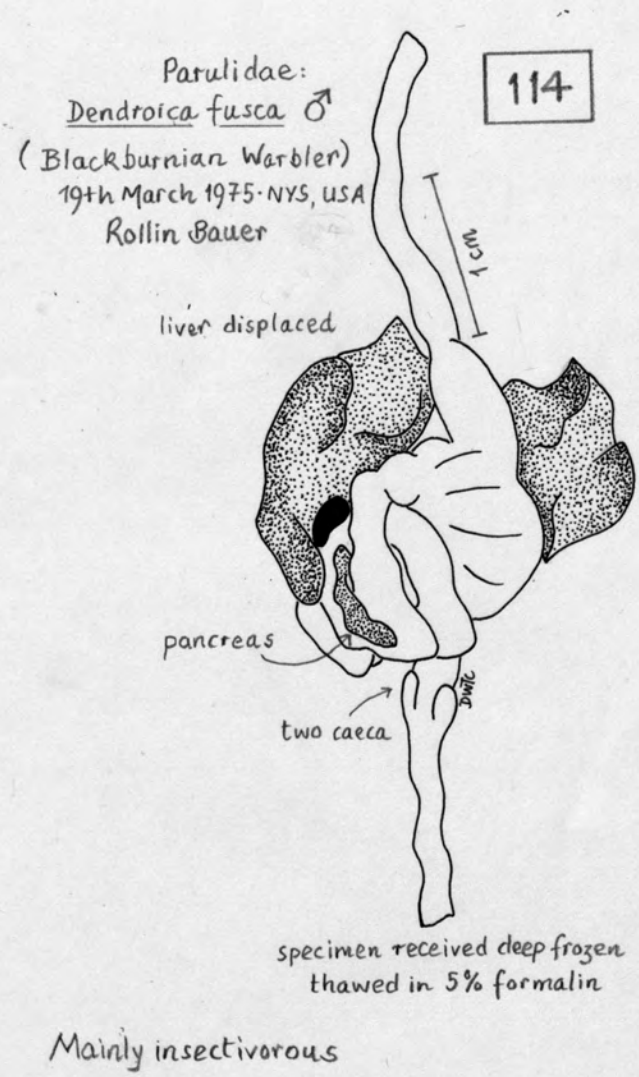
111 *Dendroicam agnolia* (Magnolia Warbler)



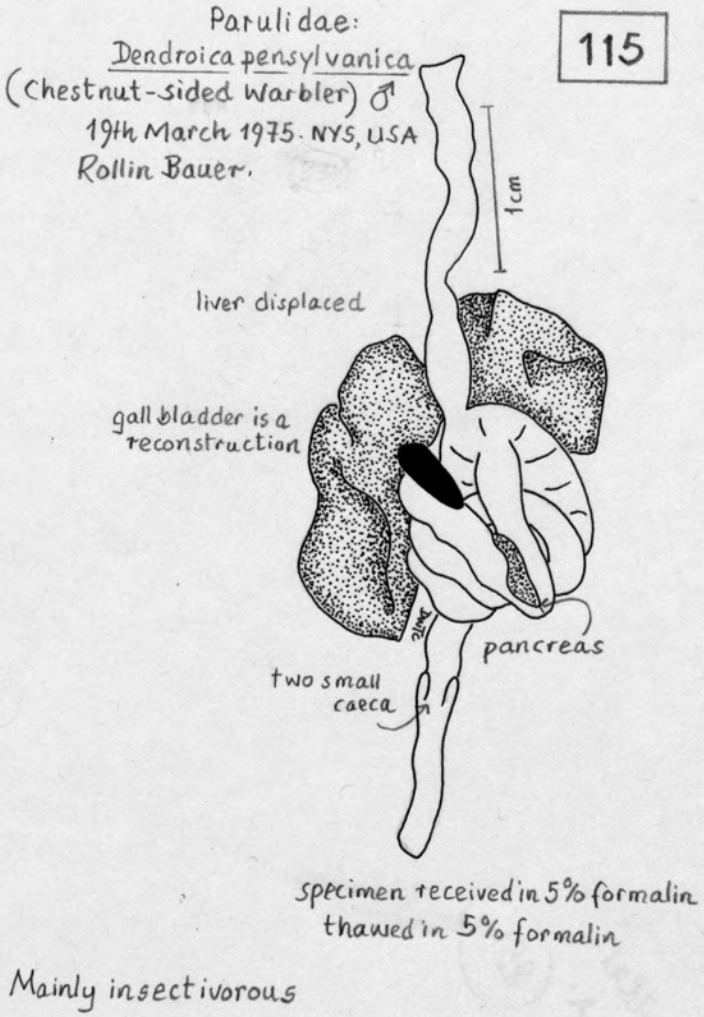
112 *Dendroica caerulescens* (Black-throated Blue Warbler)



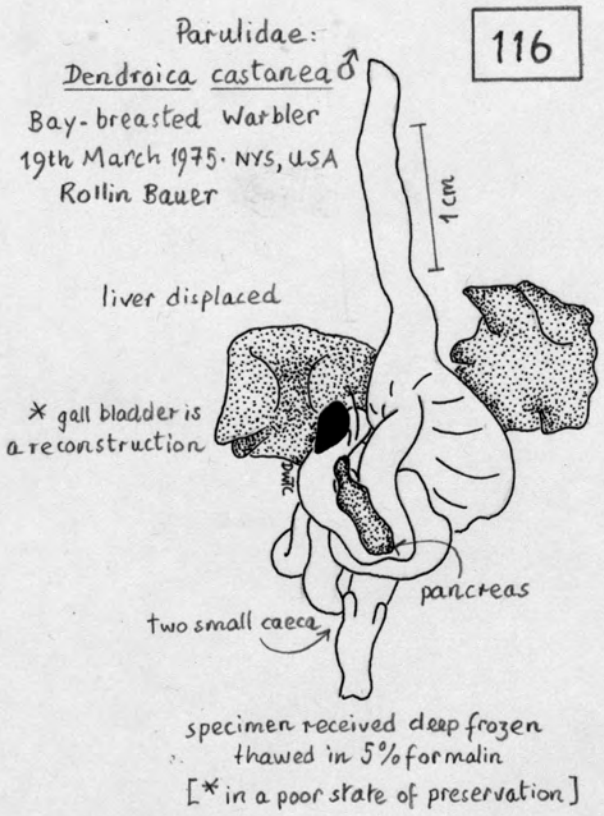
113 *Dendroica virens* (Black-throated Green Warbler)



114 *Dendroica fusca* (Blackburnian Warbler)

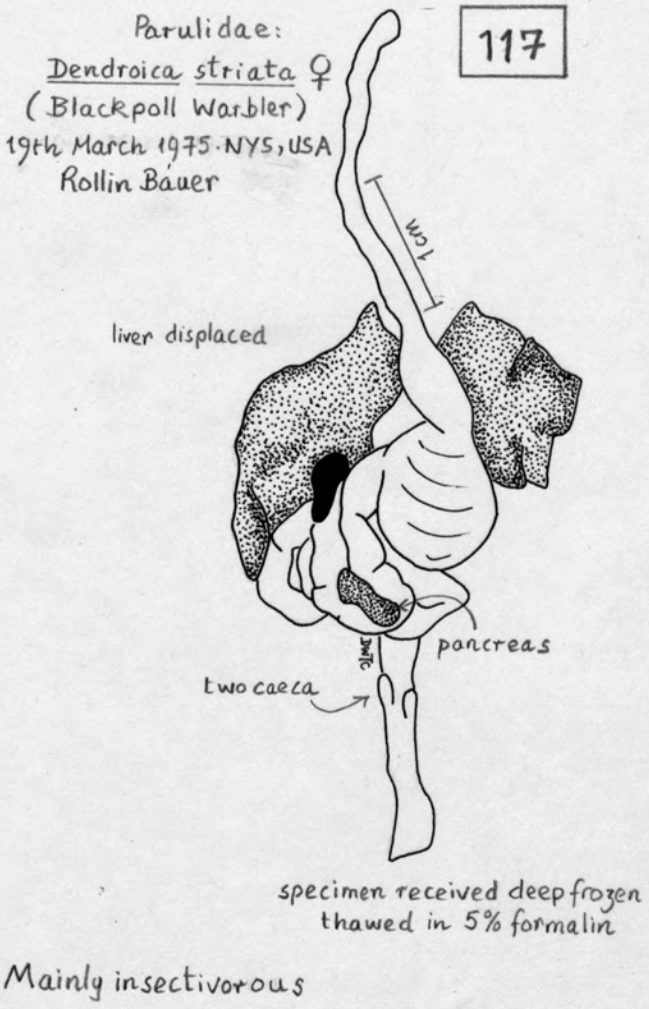


115 *Dendroica pensylvanica* (Chestnut-sided Warbler)

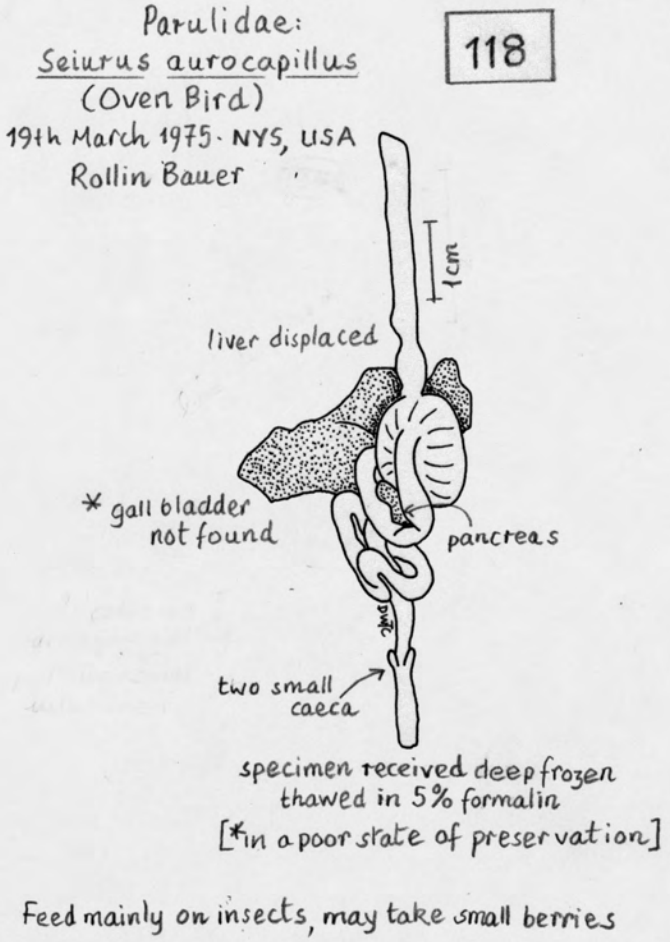


Mainly insectivorous

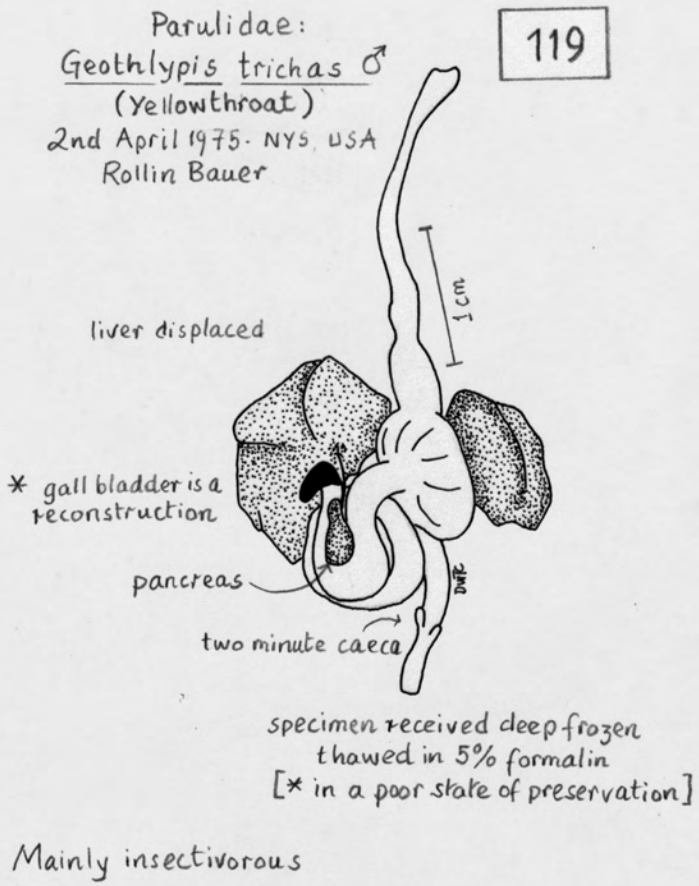
116 *Dendroica castanea* (Bay-breasted Warbler)



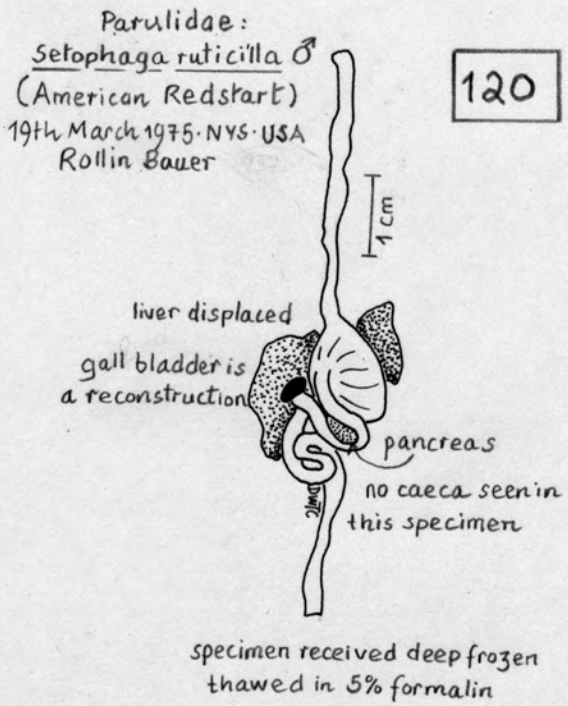
117 *Dendroica striata* (Blackpoll Warbler)



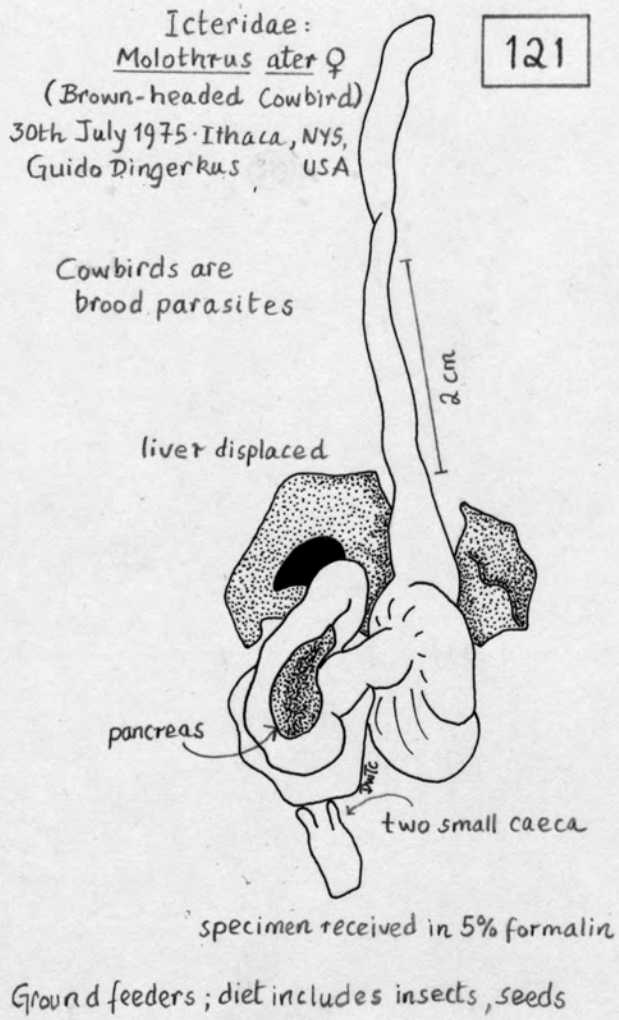
118 *Seiurus aurocapillus* (Oven Bird)



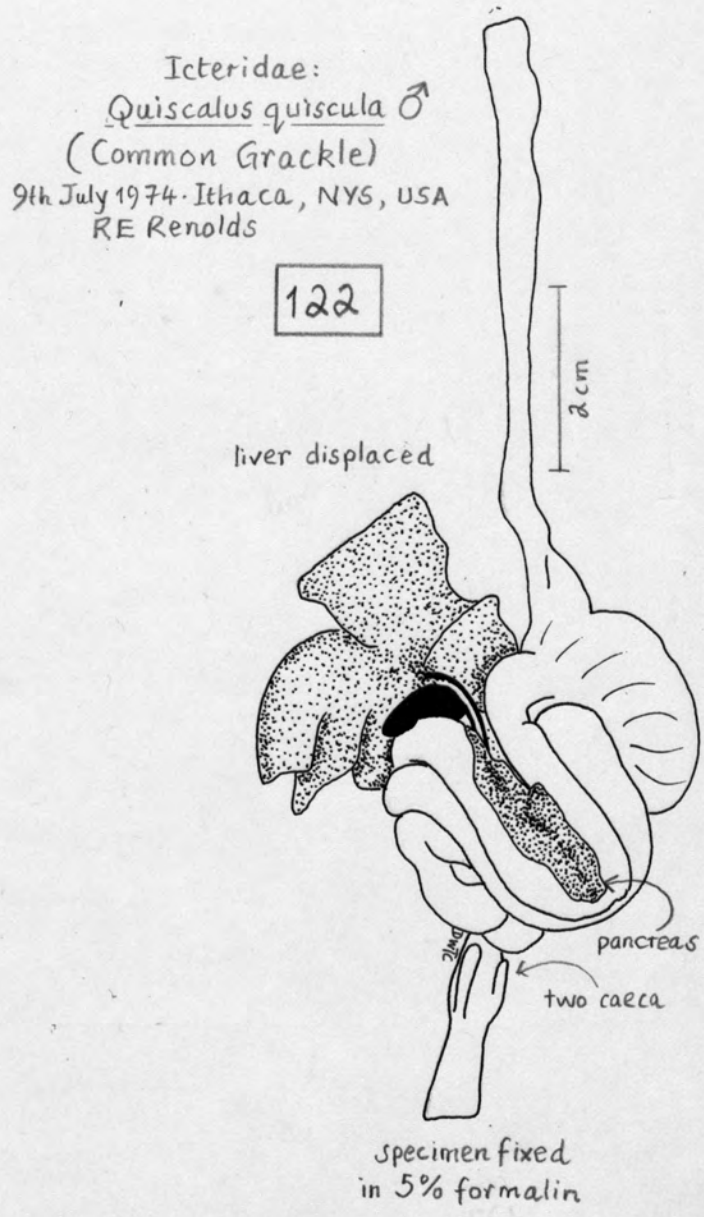
119 *Geothlypis trichas* (Yellowthroat)



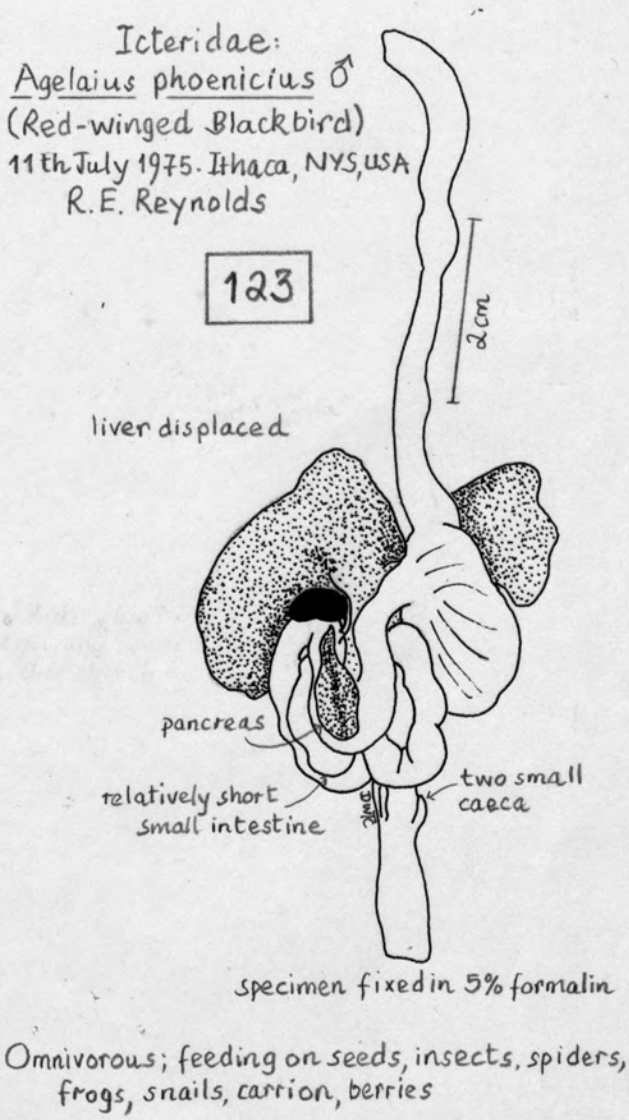
120 *Setophaga ruticilla* (American Redstart)



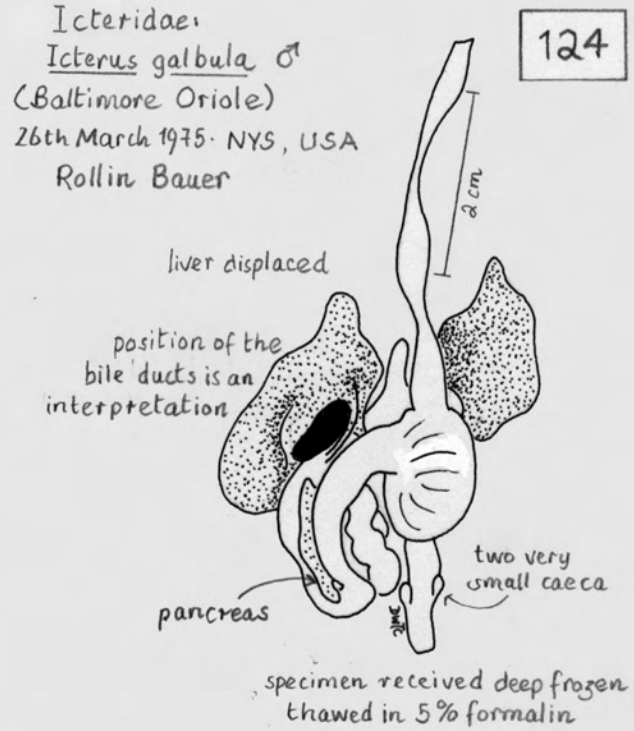
121 *Molothrus ater* (Brown-headed Cowbird)



122 *Quiscalus quiscula* (Common Grackle)



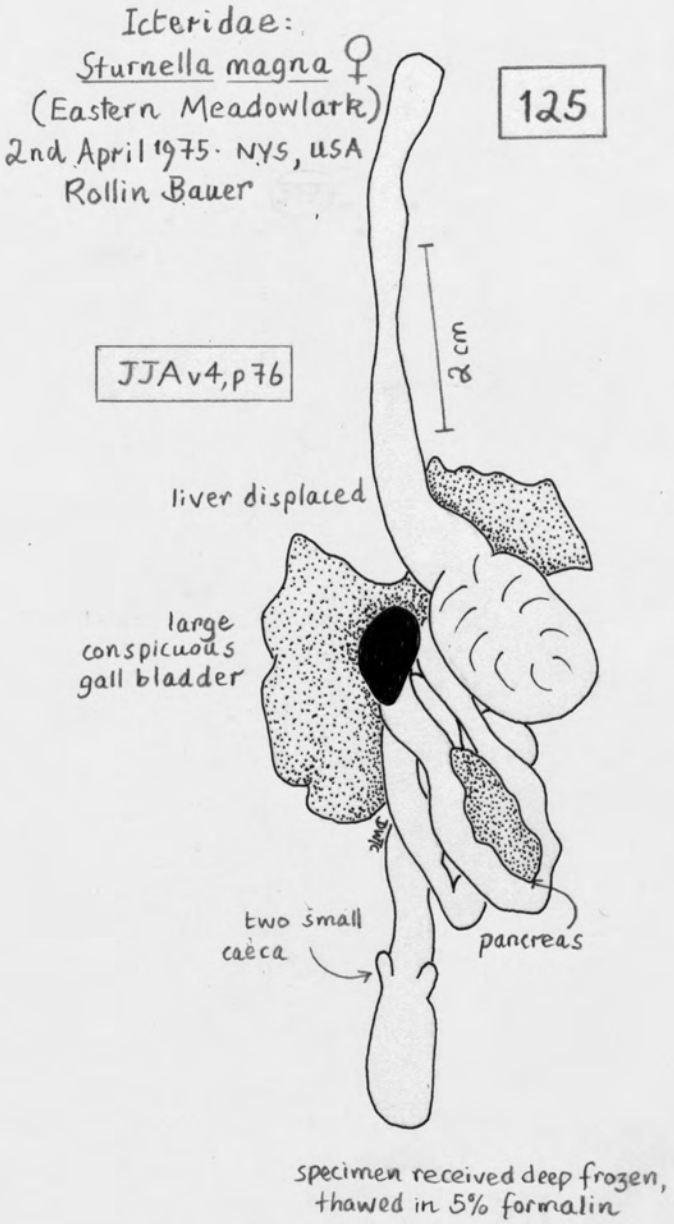
123 *Agelaius phoenicius* (Red-winged Blackbird)



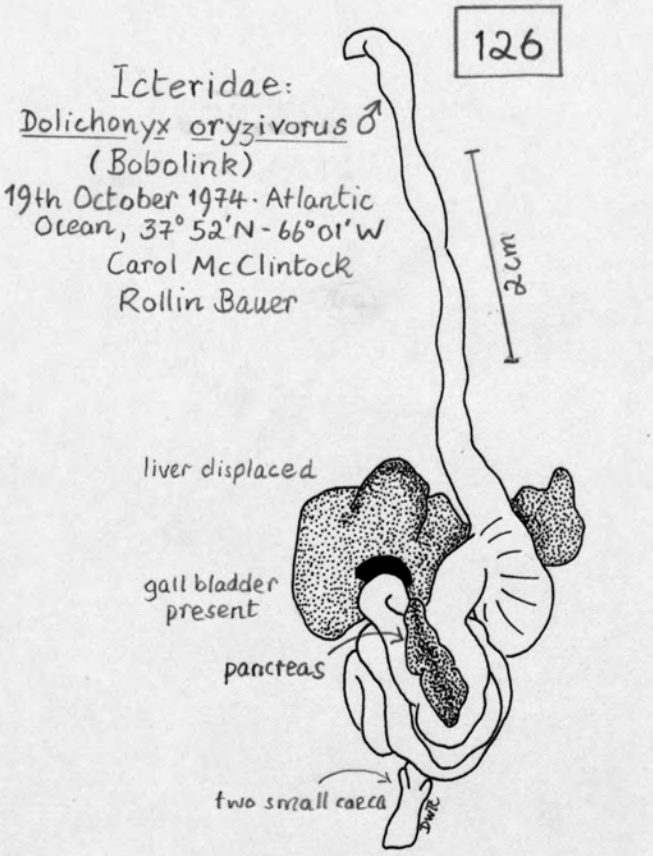
Omnivorous feeding on insects, berries, nectar

JJA v.4, p.42

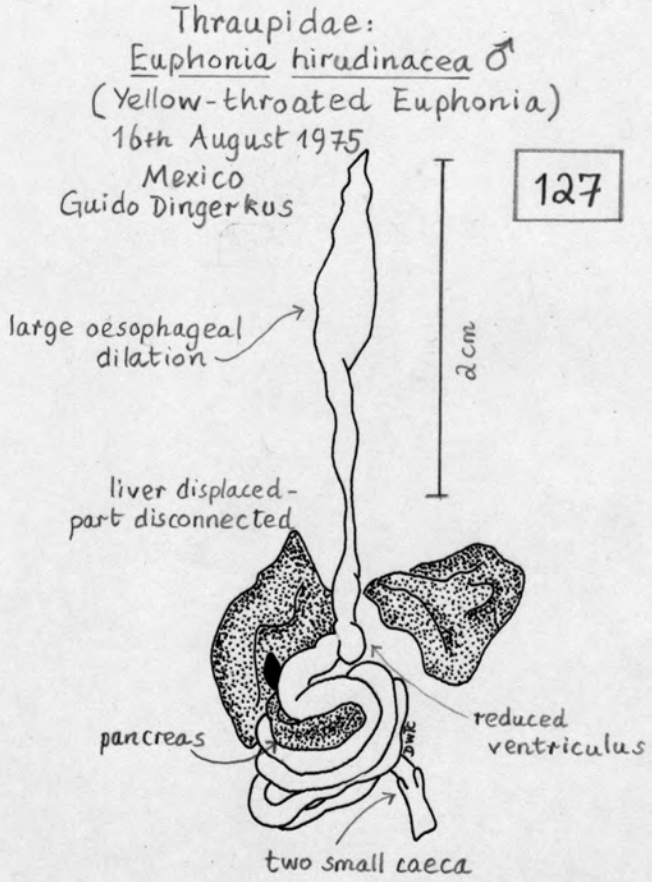
124 *Icterus galbula* (Baltimore Oriole)



125 *Sturnella magna* (Eastern Meadowlark)

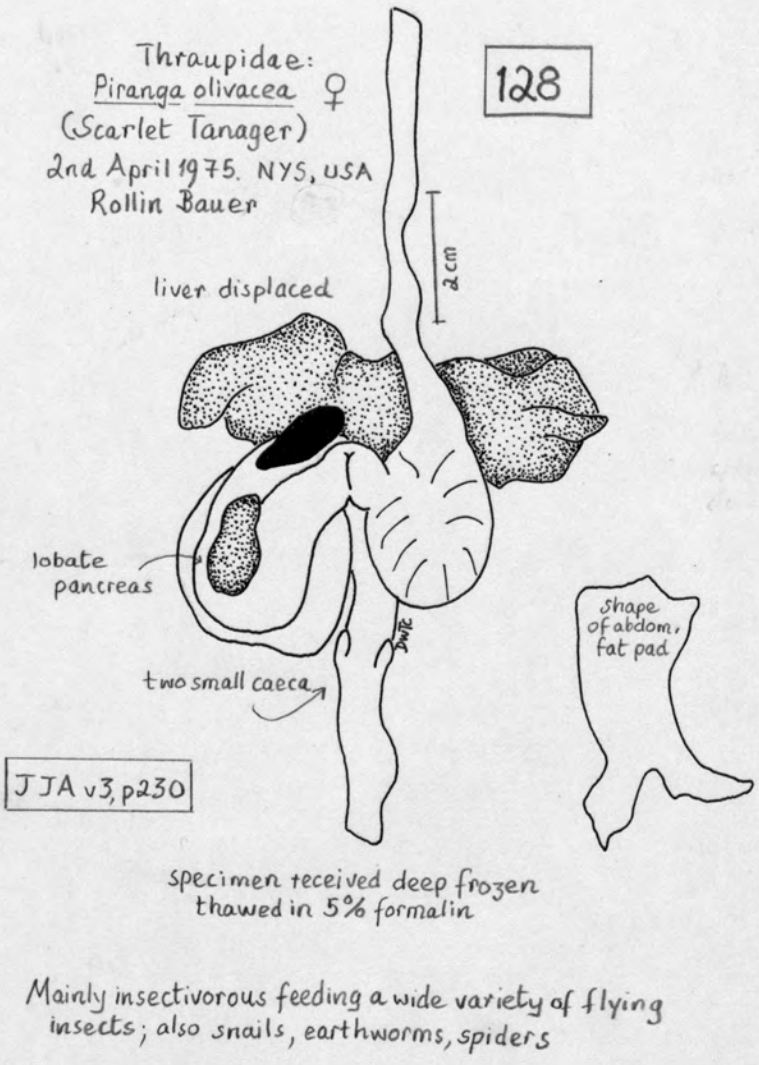


126 *Dolichonyx oryzivorus* (Bobolink)

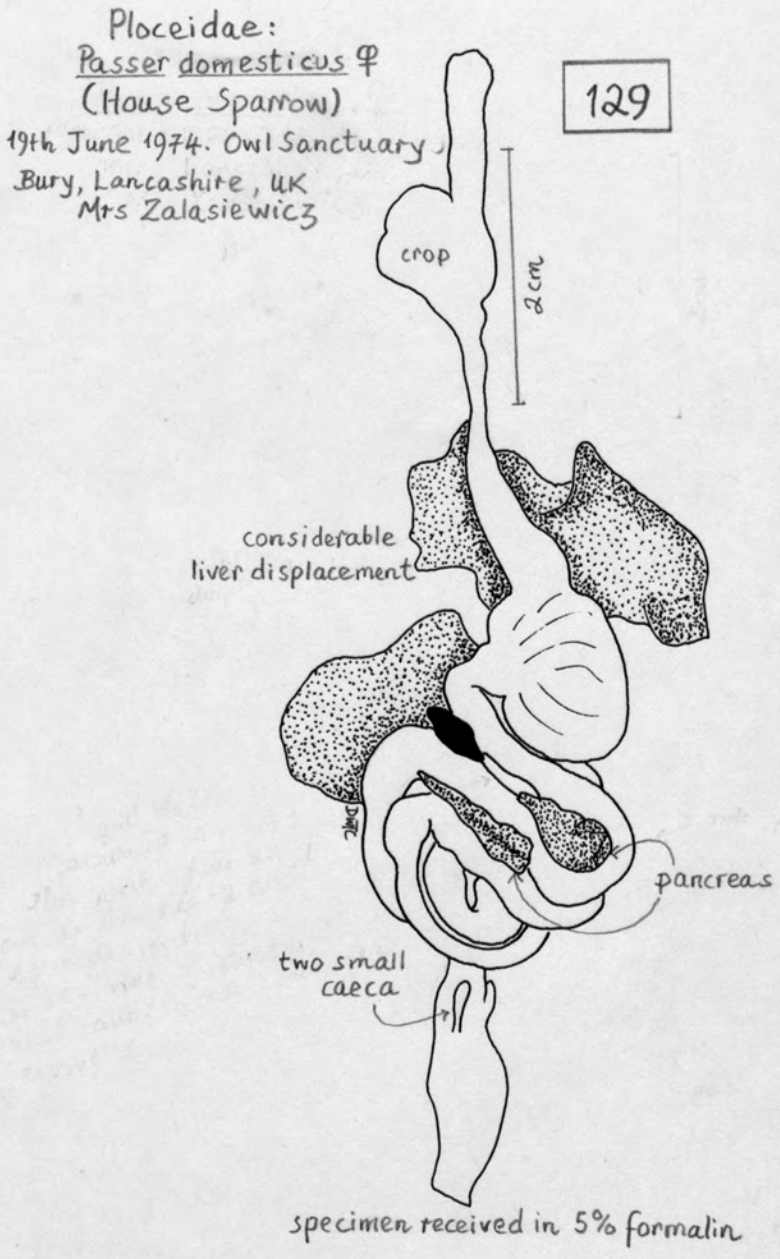


Omnivore: diet of insects, small fruits, mistletoe berries

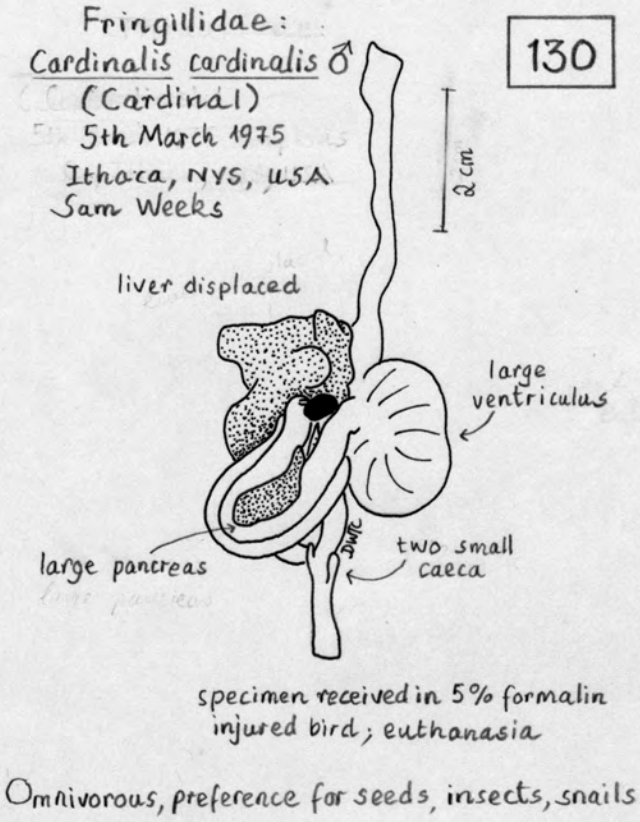
127 *Euphonia hirudinacea* (Yellow-throated Euphonia)



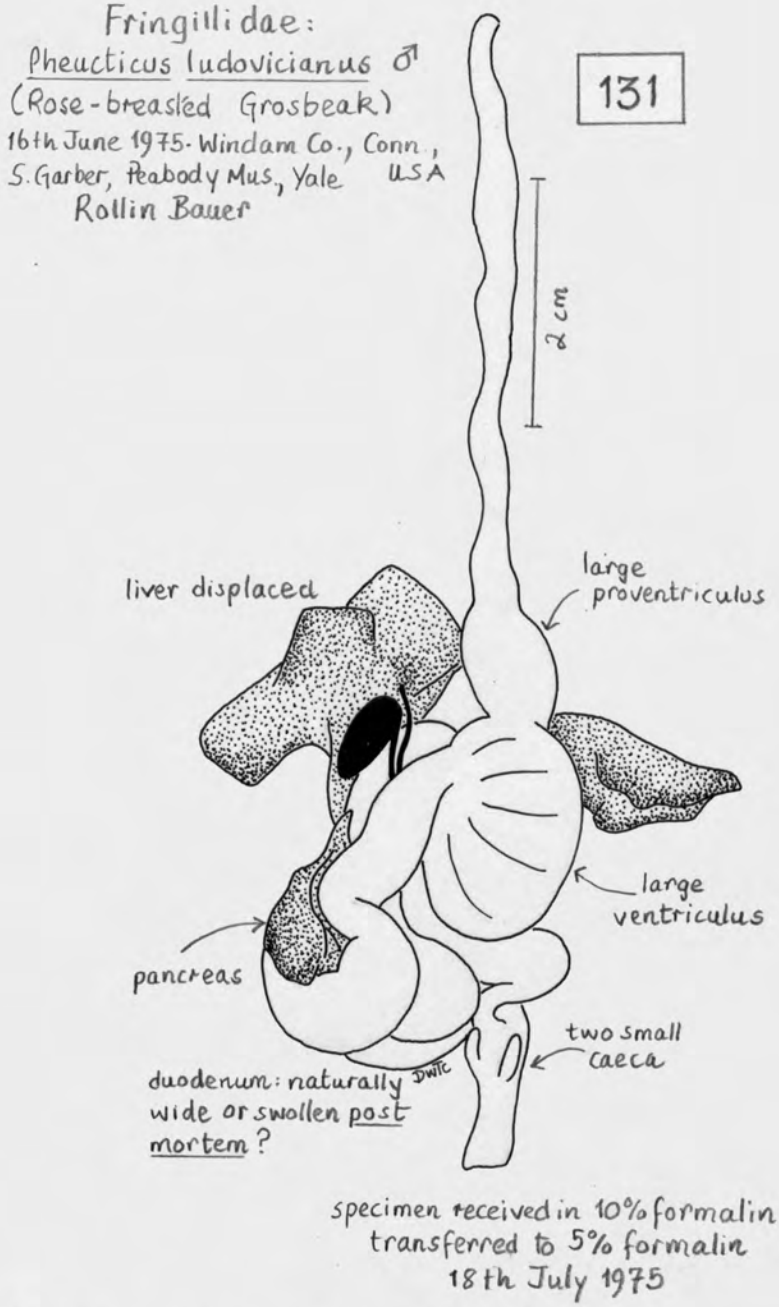
128 *Piranga olivacea* (Scarlet Tanager)



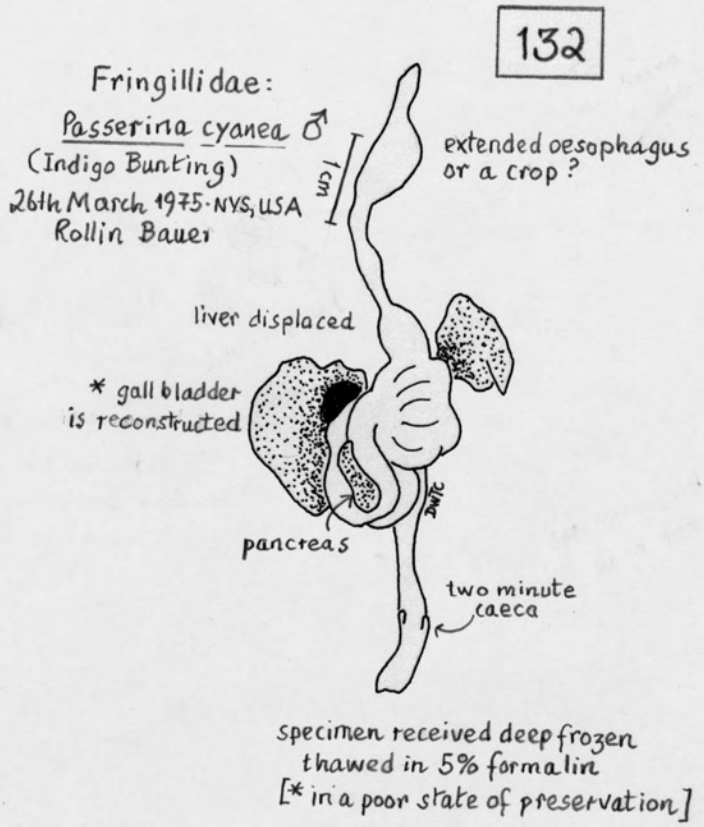
129 *Passer domesticus* (House Sparrow)



130 *Cardinalis cardinalis* (Cardinal)

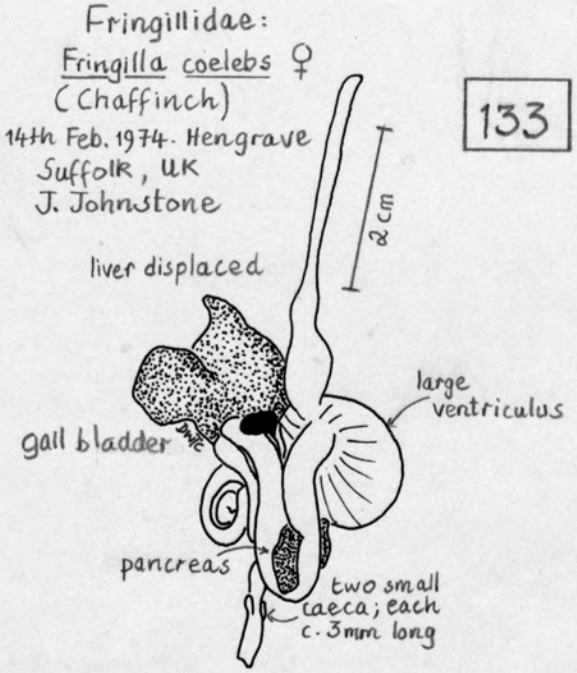


131 *Pheuticus ludovicianus* (Rose-breasted Grosbeak)

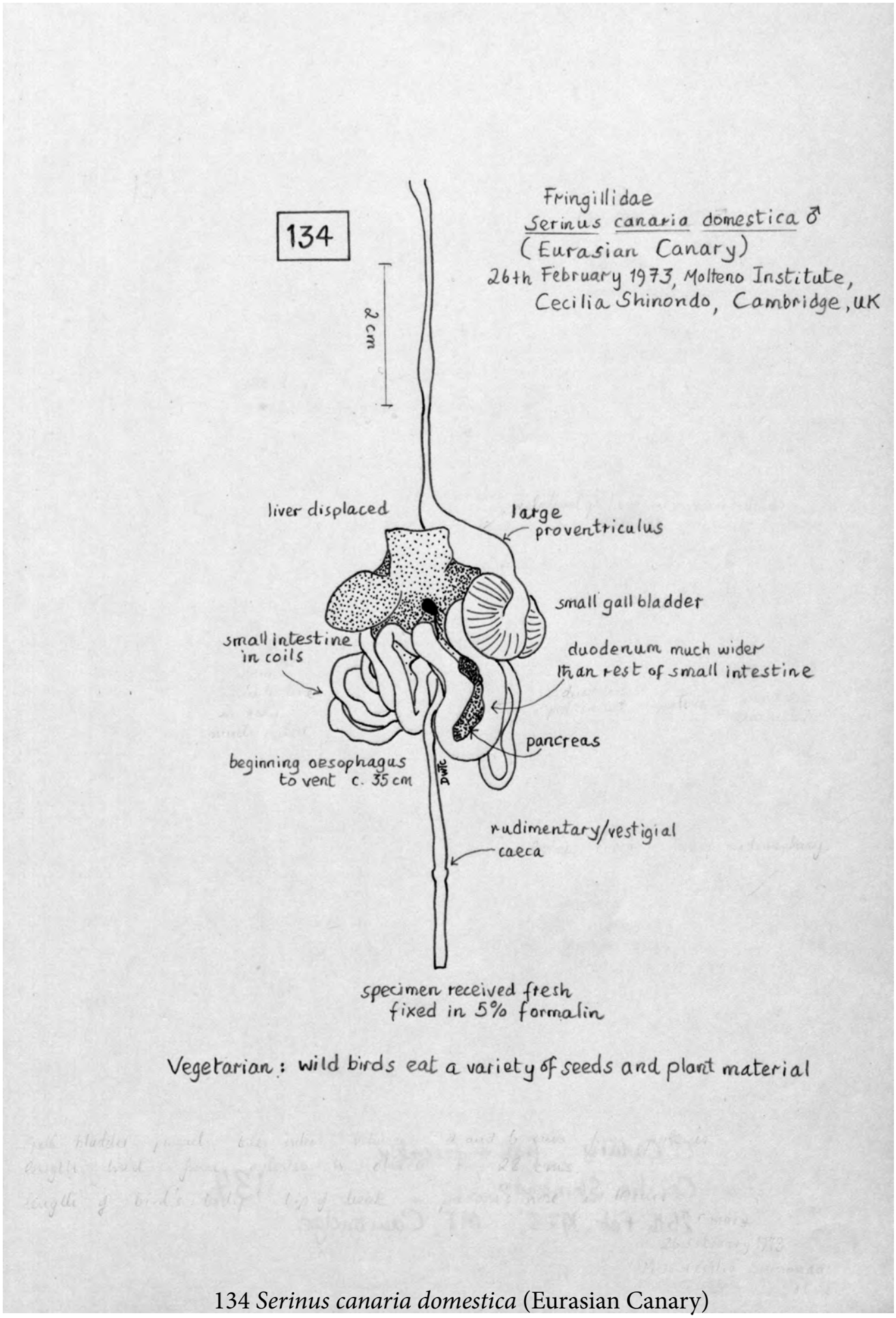


Omnivorous, seeds, buds, insects, spiders

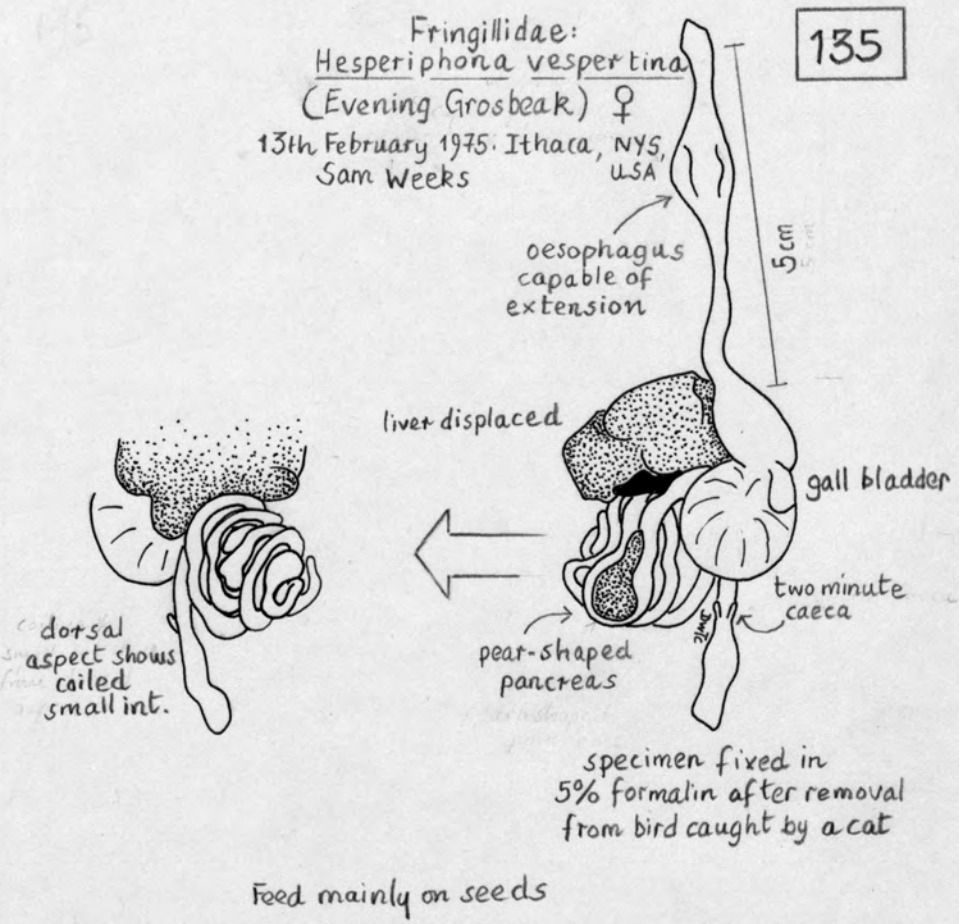
132 *Passerina cyanea* (Indigo Bunting)



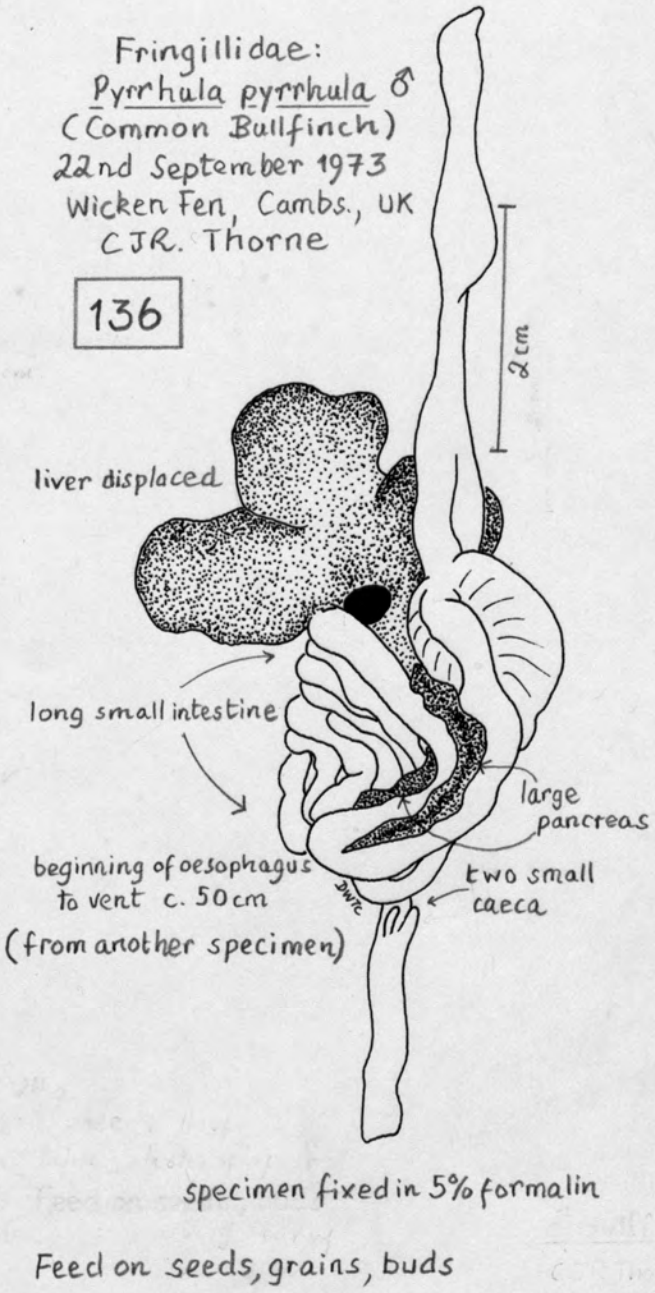
133 *Fringilla coelebs* (Chaffinch)



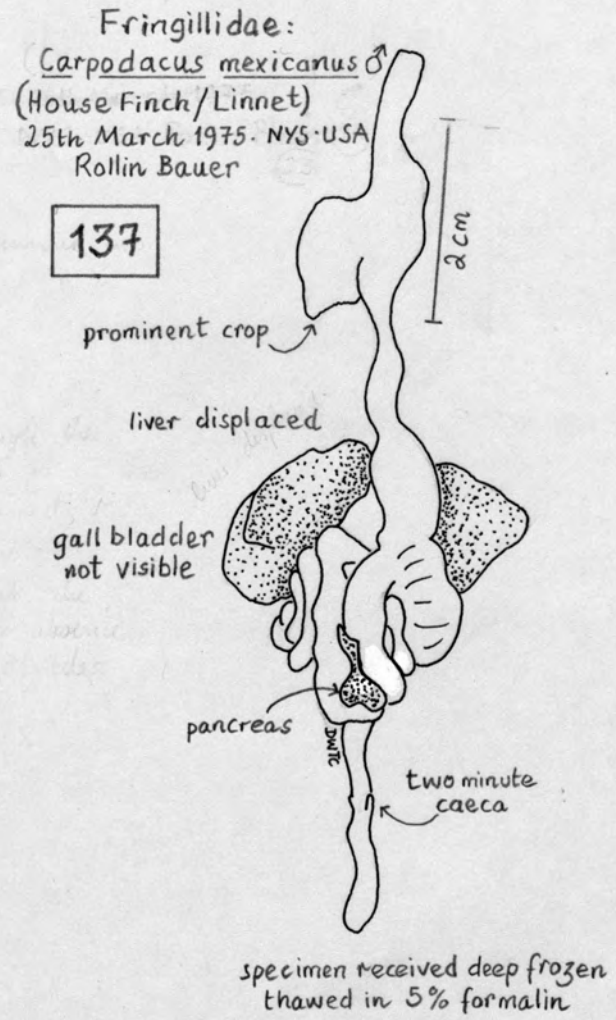
134 *Serinus canaria domestica* (Eurasian Canary)



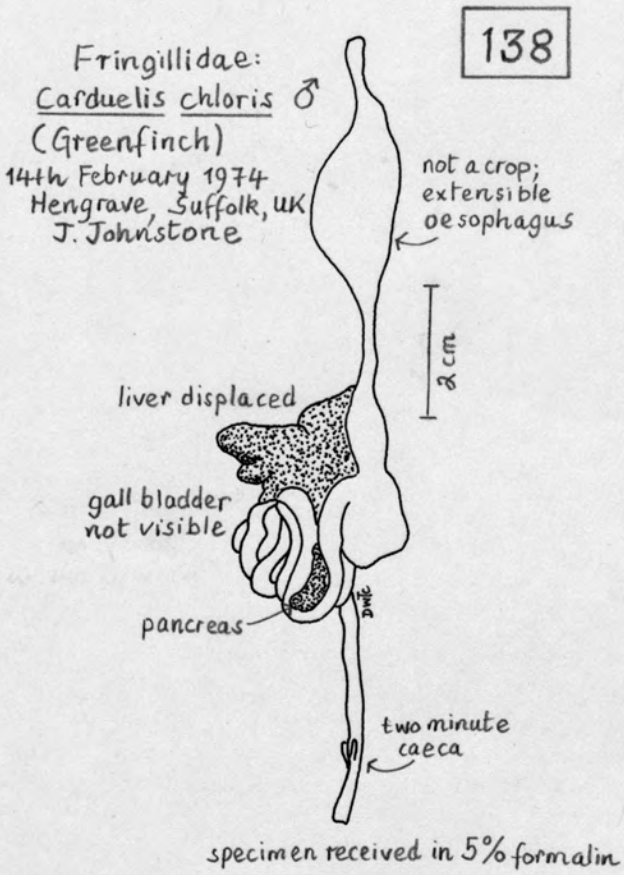
135 *Hesperiphona vespertina* (Evening Grosbeak)



136 *Pyrrhula pyrrhula* (Common Bullfinch)

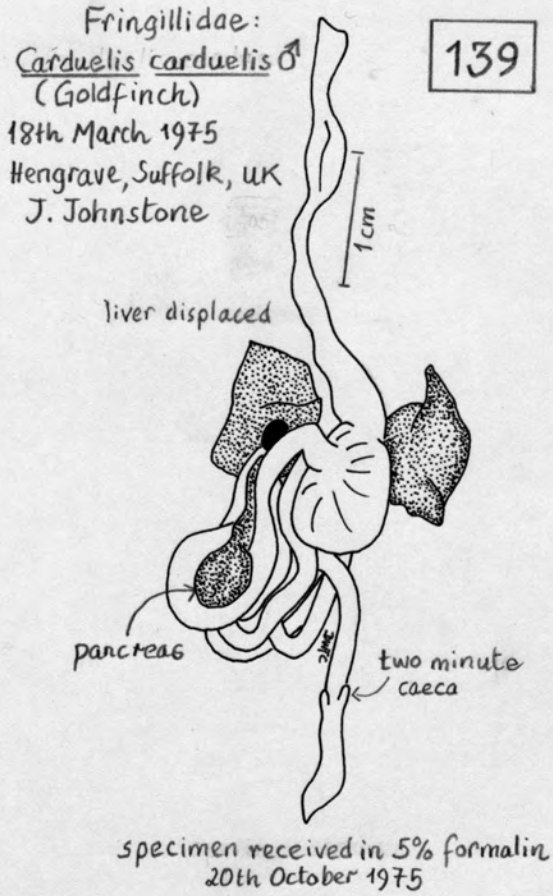


137 *Carpodacus mexicanus* (House Finch/Linnet)

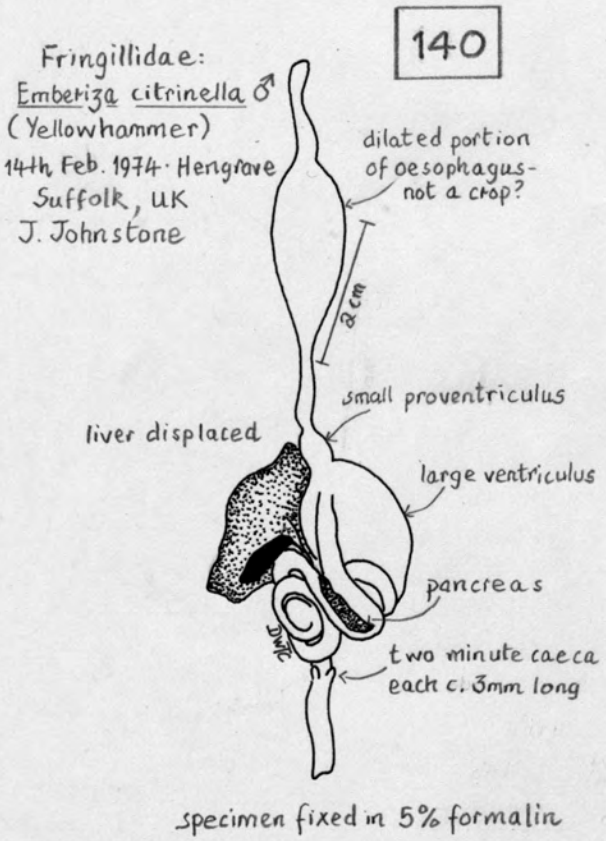


Feed on seeds, berries, insects

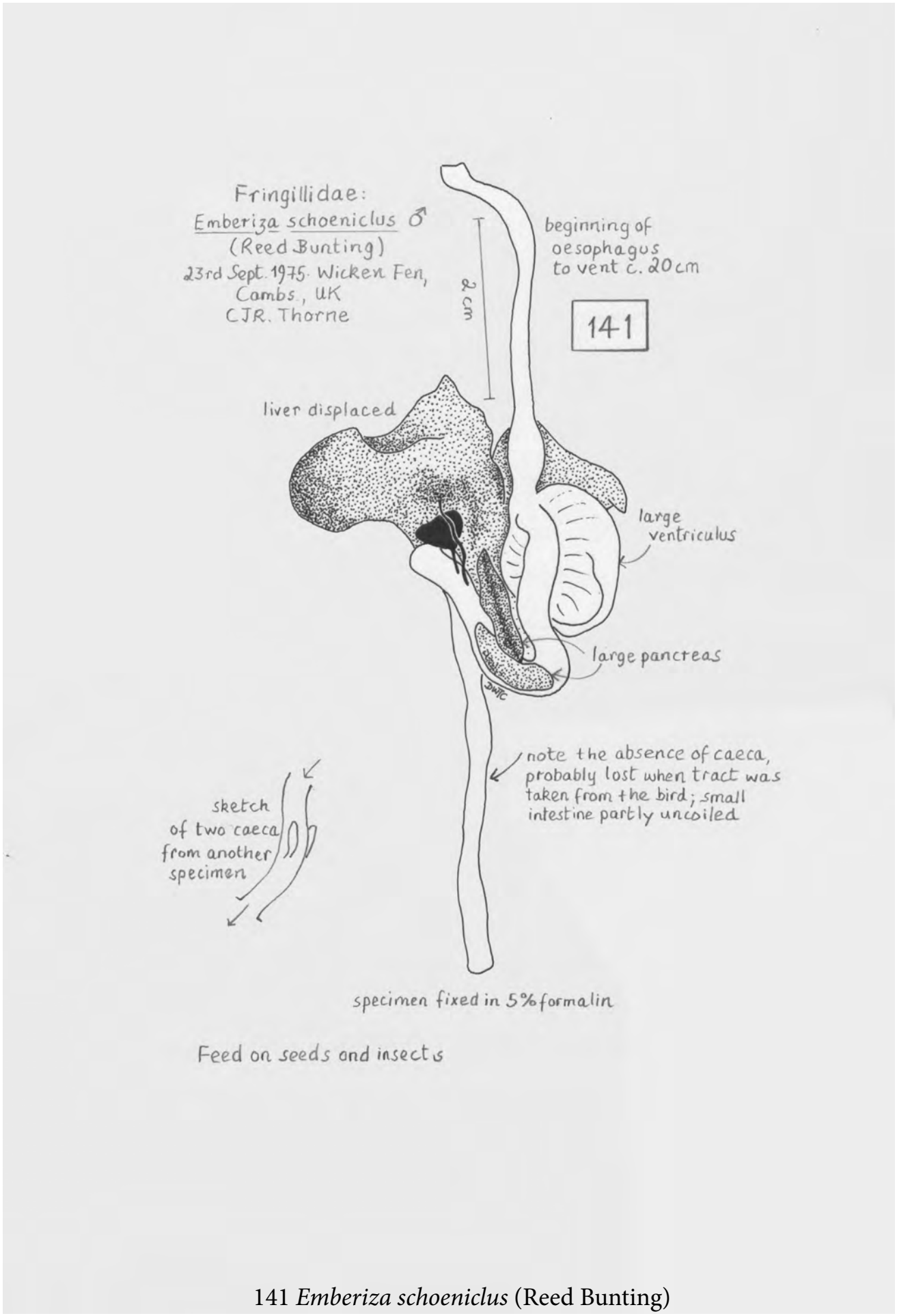
138 *Carduelis chloris* (Greenfinch)



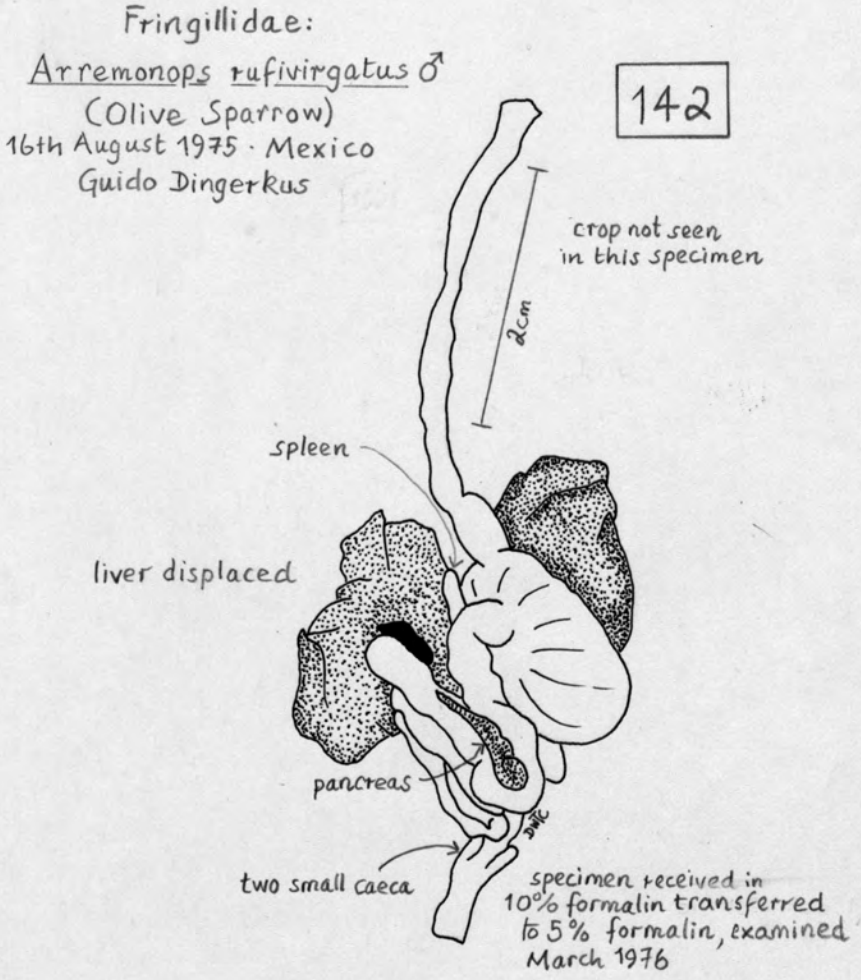
139 *Carduelis carduelis* (Goldfinch)



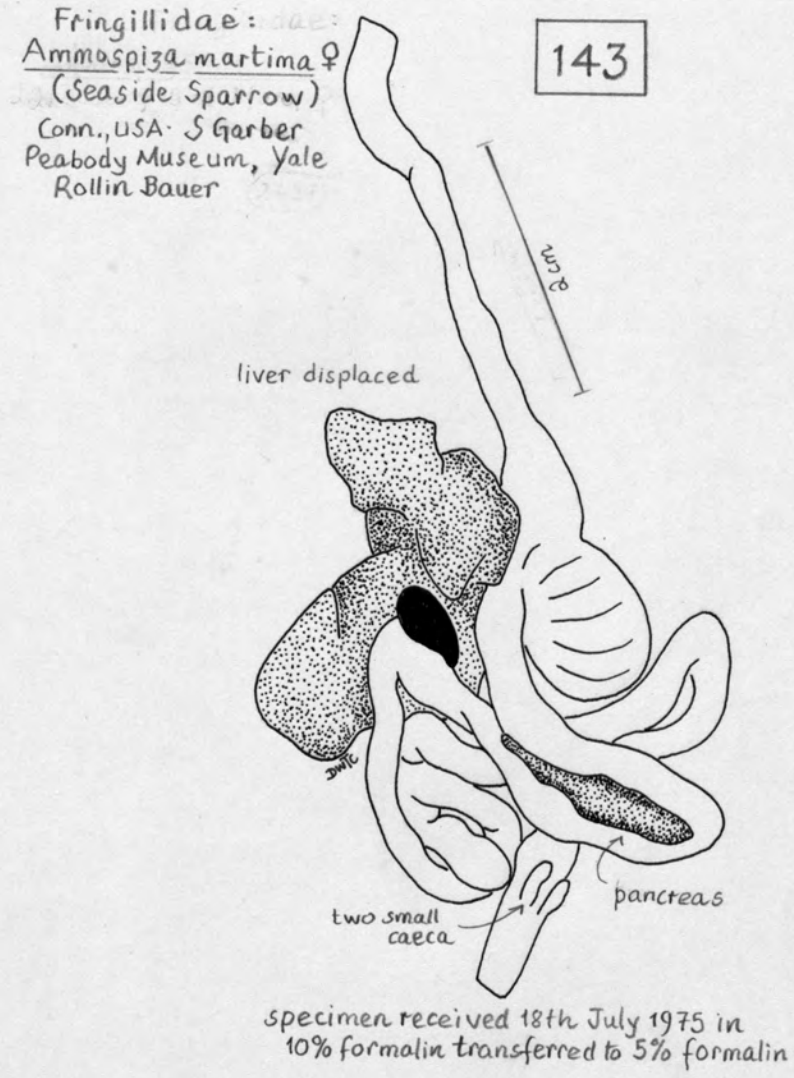
140 *Emberiza citronella* (Yellowhammer)



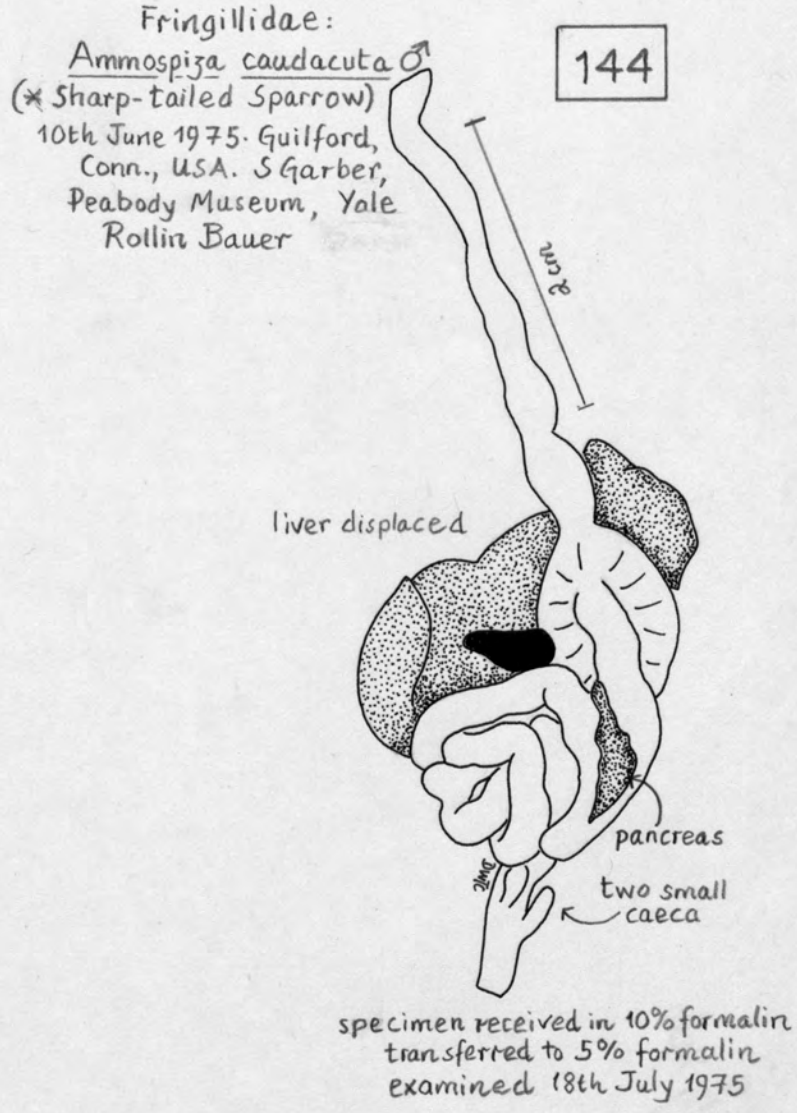
141 *Emberiza schoeniclus* (Reed Bunting)



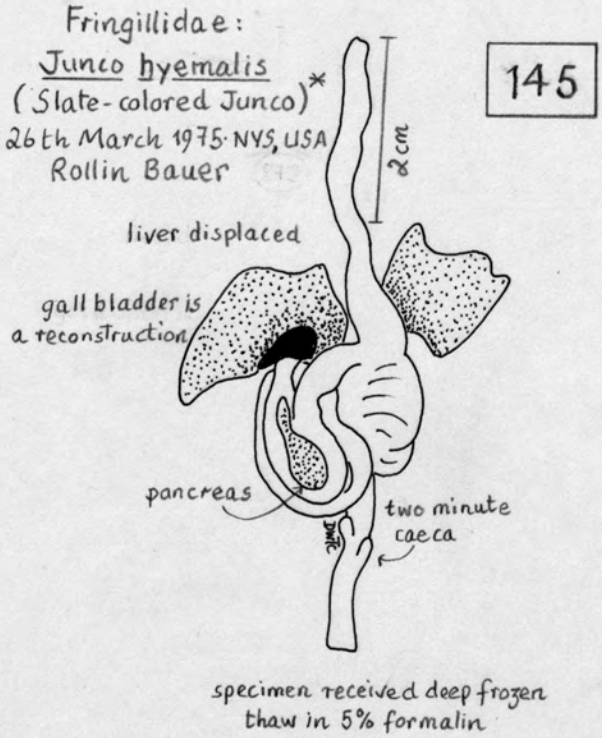
142 *Arremonops rufivirgatus* (Olive Sparrow)



143 *Ammospiza martima* (Seaside Sparow)



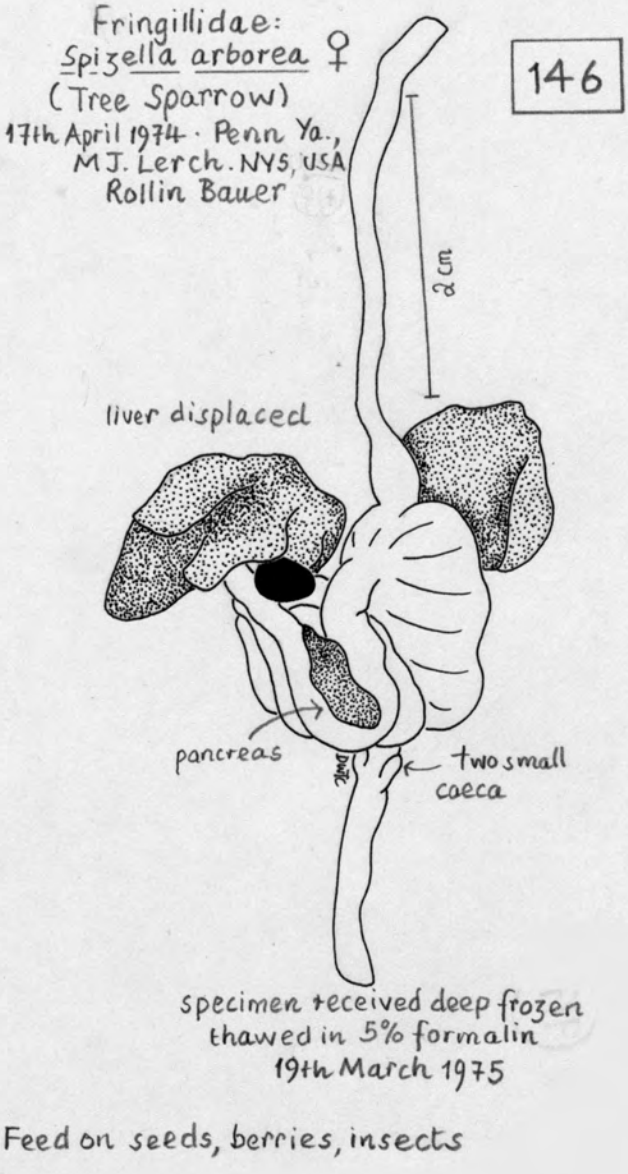
144 *Ammospiza caudacuta* (Sharp-tailed Sparrow)



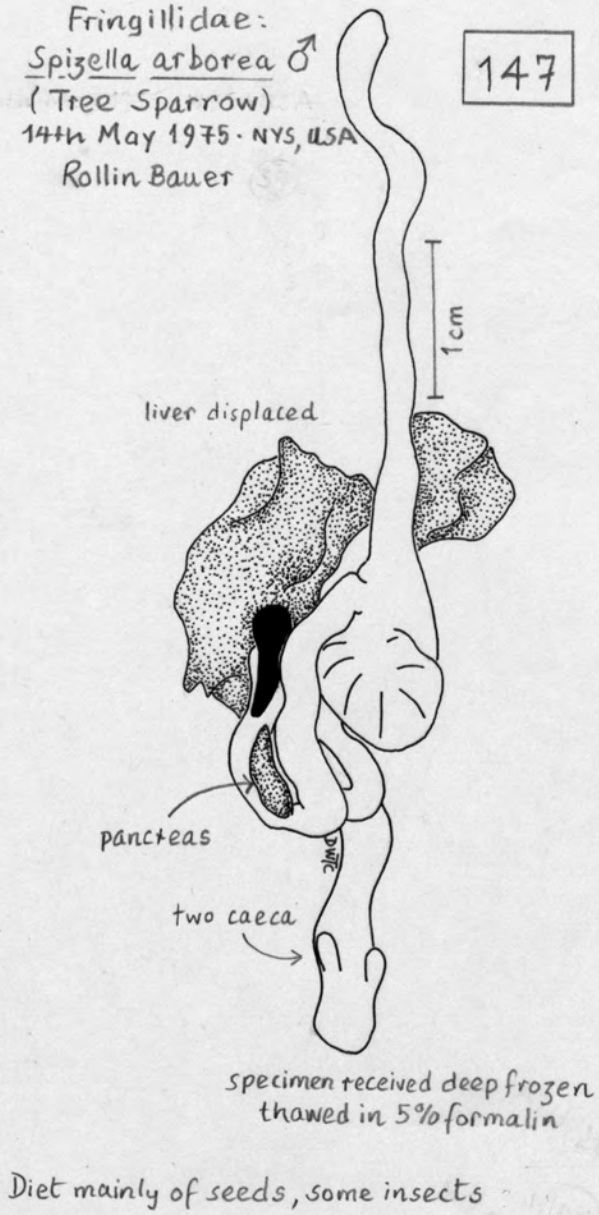
Omnivorous; insects and seeds

* listed by Clements (1974) as Dark-eyed Junco

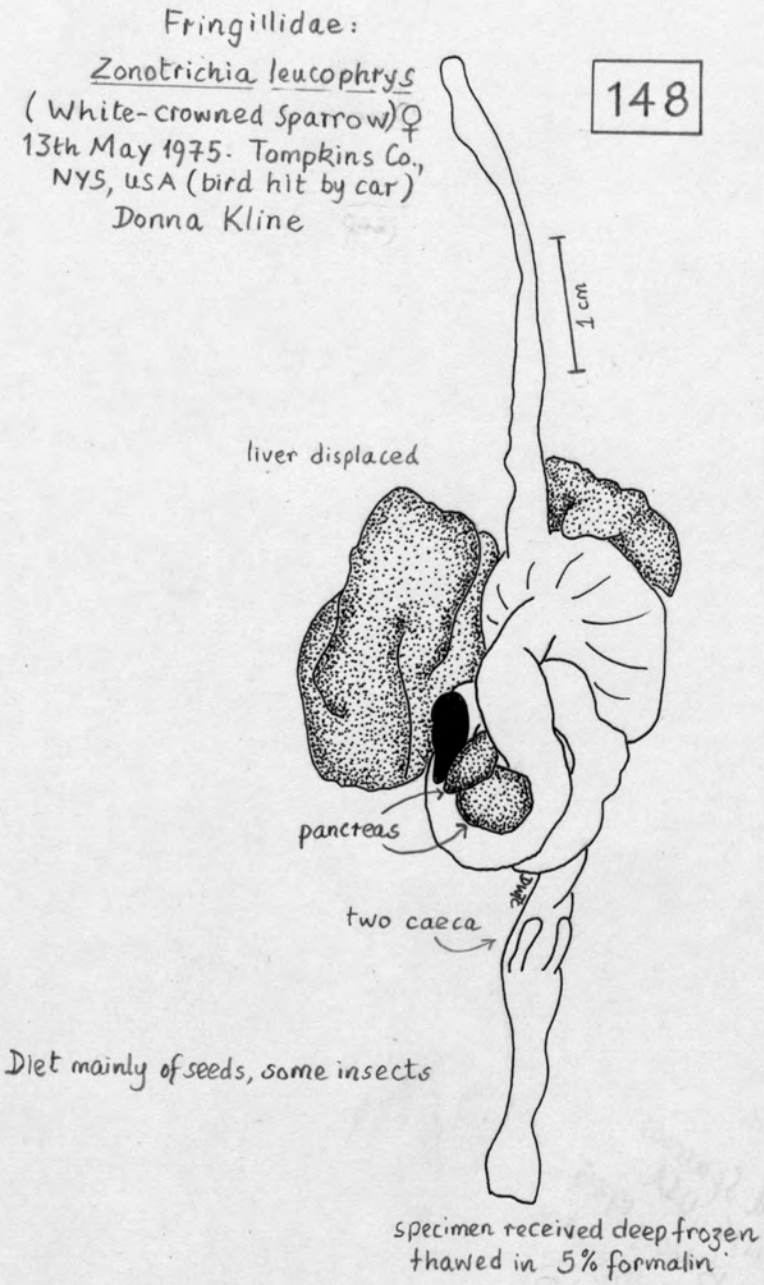
145 *Junco hyemalis* (Slate-colored Junco)



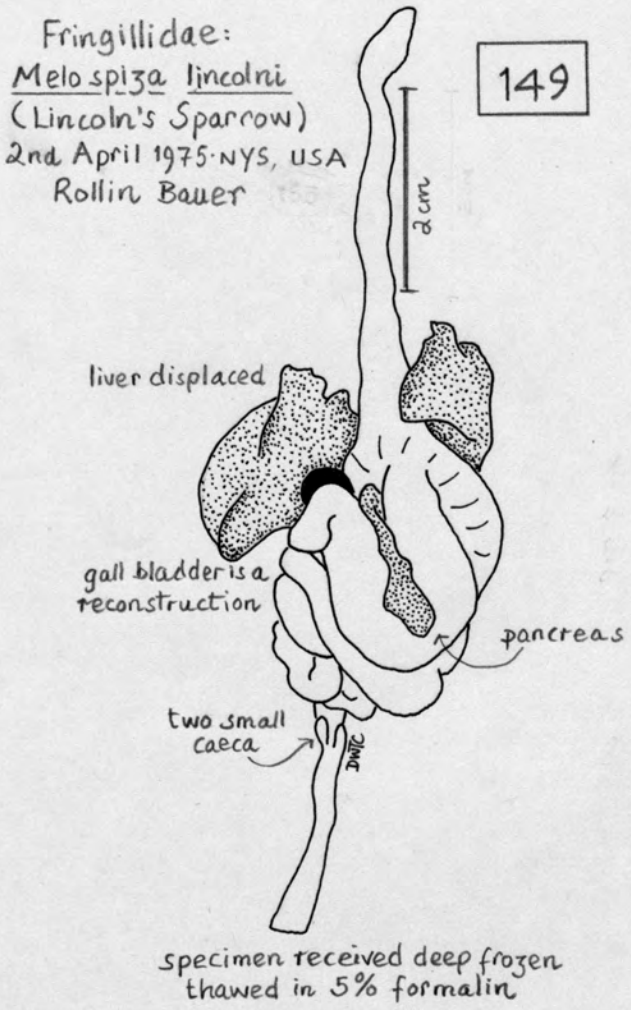
146 *Spizella arborea* (Tree Sparrow)



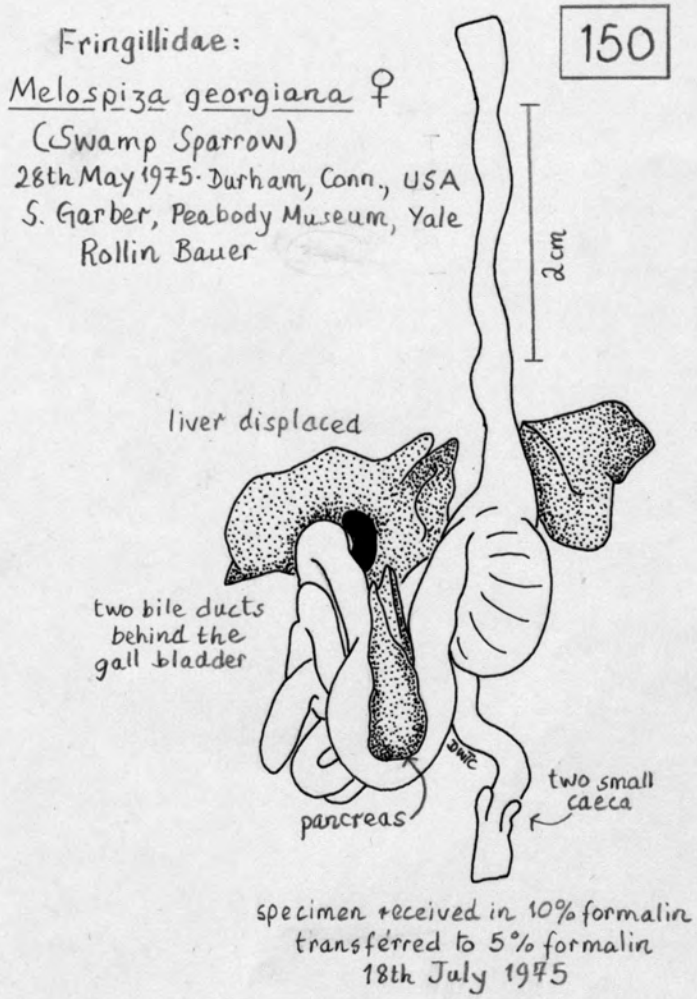
147 *Spizella arborea* (Tree Sparrow)



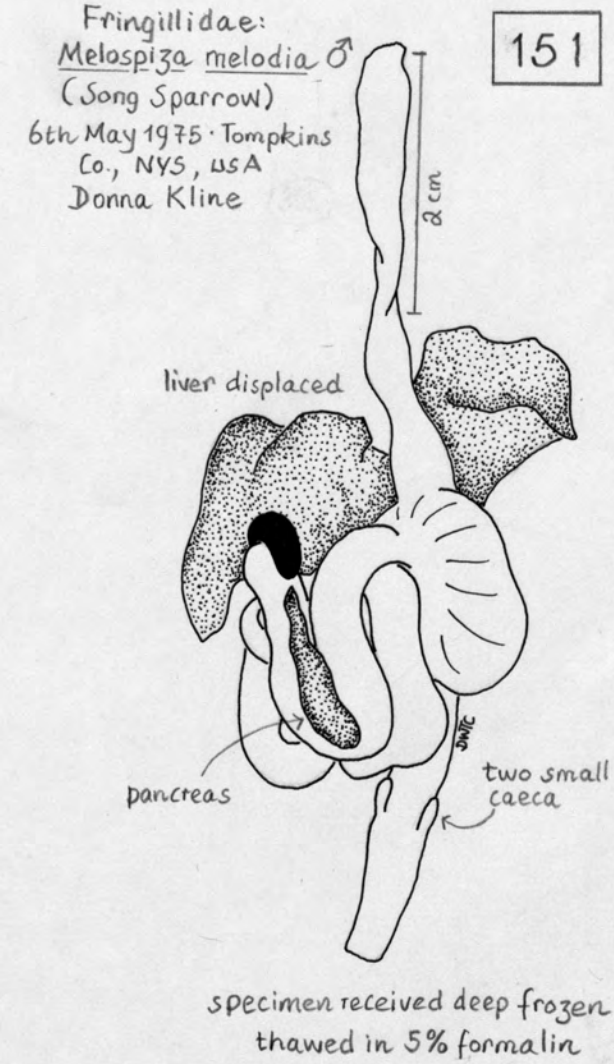
148 *Zonotrichia leucophrys* (White-crowned Sparrow)



149 *Melospiza lincolni* (Lincoln's Sparow)



150 *Melospiza georgiana* (Swamp Sparrow)



151 *Melospiza melodia* (Song Sparrow)

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